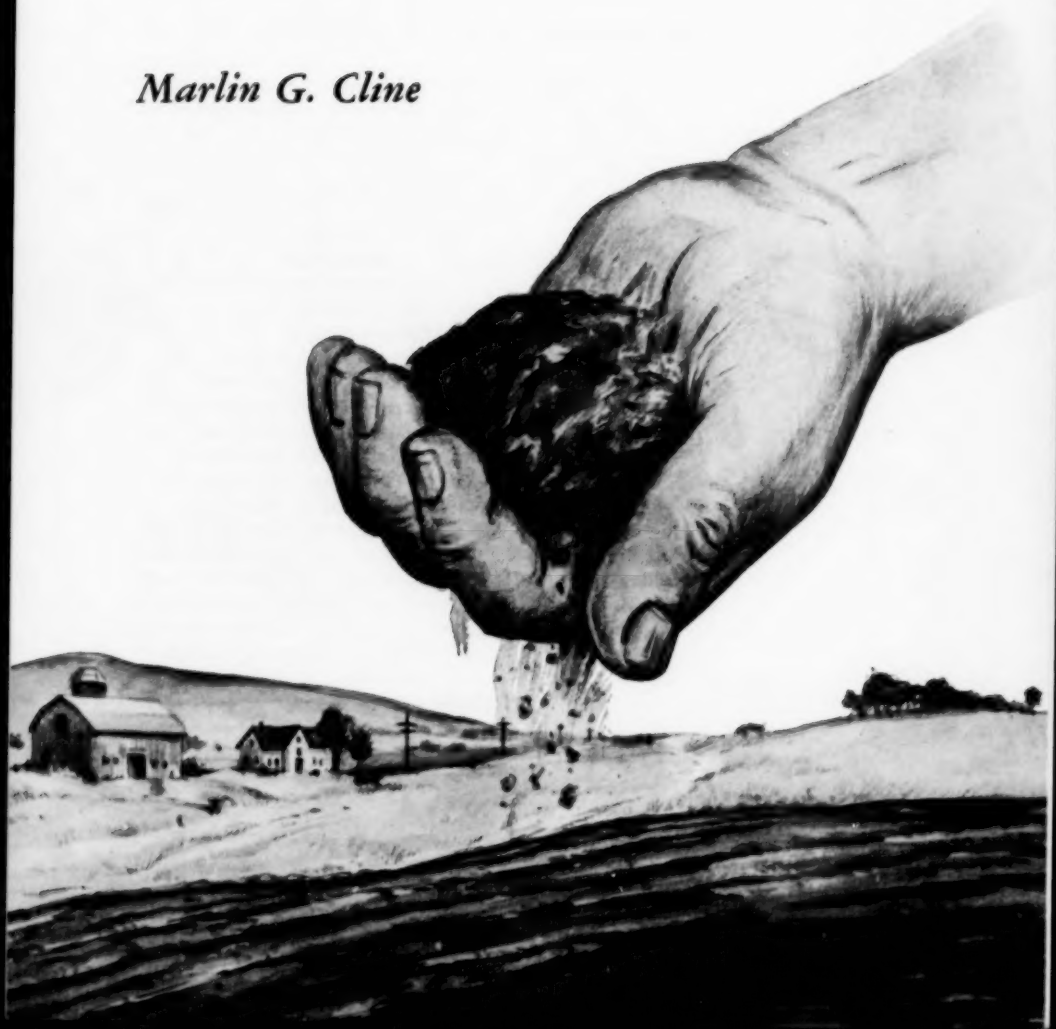
CORNELL EXTENSION BULLETIN 930

SOILS and SOIL ASSOCIATIONS OF NEW YORK

Marlin G. Cline



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Soils and Soil Associations of New York

MARLIN G. CLINE

THIS bulletin and the soil map it contains have been prepared for persons who want a picture of the soil resources of whole communities. If you want soil information for individual farm planning or for appraisal of the soil resources of individual fields or farms, you should refer to the detailed soil maps now being made on aerial photographs and obtainable from the county soil conservation office. For general information about the soils of larger areas, however, this bulletin and its map are more useful than the detailed maps and reports.

To use the map and soil information most effectively, you need to know something of the State as a whole—its geology and its climate. You need also to know what kinds of soils are in the State and how they are associated one with another. For this reason, the first part of the bulletin reviews these briefly. The second part describes the soil areas outlined on the map in terms of the soils that are found in each area and their important capabilities and limitations for agricultural use.

Physiographic Areas

PERSONS find it convenient to refer to twelve distinct physiographic areas when discussing different parts of the State. These are outlined in figure 1. Seven of the areas are distinct valleys or lowlands and five are highlands or mountainous areas.

The lowland areas occupy about one-third of the total area of the State. The most productive soils, the most favorable topography, and the best road and railroad systems are in these areas. The highest proportion of cultivated land is in the lowlands.

The highland areas vary in their suitability for agriculture. In the

AUTHOR'S ACKNOWLEDGMENT. Dr. A. J. Baur, Soil Conservation Service, United States Department of Agriculture, contributed to the development of the soil-association map and the key to soil series of New York.

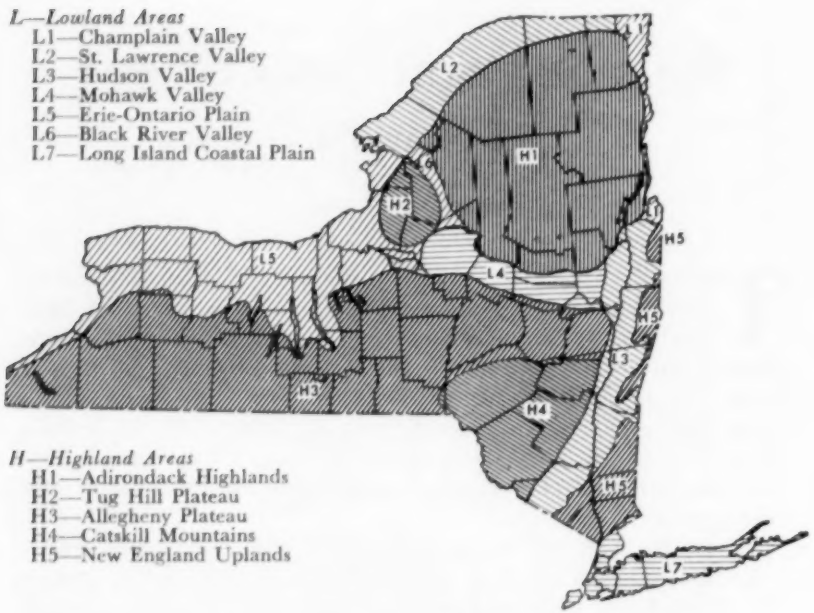


Figure 1. Physiographic areas of New York State

Adirondack highlands and the Catskill Mountains, you will find very stony soils, much rock outcrop, and unfavorable topography. Little agriculture is practiced in these areas. On the Tug Hill Plateau there is also much stoniness and essentially no agriculture, although the topography does not seriously limit agriculture.

The Allegheny Plateau is a highland area cut by valleys at variable intervals. In the westernmost part and along the borders of the Erie–Ontario Plain, the hills are smoothly sloping, although they rise several hundred feet above the valley floor. Most of this part is cultivable, although restricted soil drainage is a major problem. South of the Finger Lakes region are steep-sided valleys with level valley floors and some moderately sloping hilltops. In these places, the hilltops are potentially productive but difficult of access, and the valley floors have some of the most productive soil of the State. The hillsides, however, are either steep or somewhat poorly drained and are poor agricultural areas. In southern Cattaraugus and Allegany Counties and on the borders of the Catskill Mountains, there are steep hillsides, narrow valleys,

and small hilltop remnants. Here much of the land is non-agricultural or is used mainly for hay and pasture.

The New England Upland areas are characterized by steep, stony hills between narrow valleys in which the agriculture is concentrated.

Climate

THE lowland areas are generally warmer than the adjacent highlands, and temperatures are generally higher in the south than at equal elevations in the north. Near Lakes Erie and Ontario and on the Long Island Coastal Plain, the climate is somewhat modified by the nearness of large bodies of water.

The average length of the growing season is shown in figure 2. Notice that Long Island, the lower part of the Hudson Valley, and much of the Erie–Ontario Plain have more than a 165-day growing season. The lowland areas of the north have a growing season similar

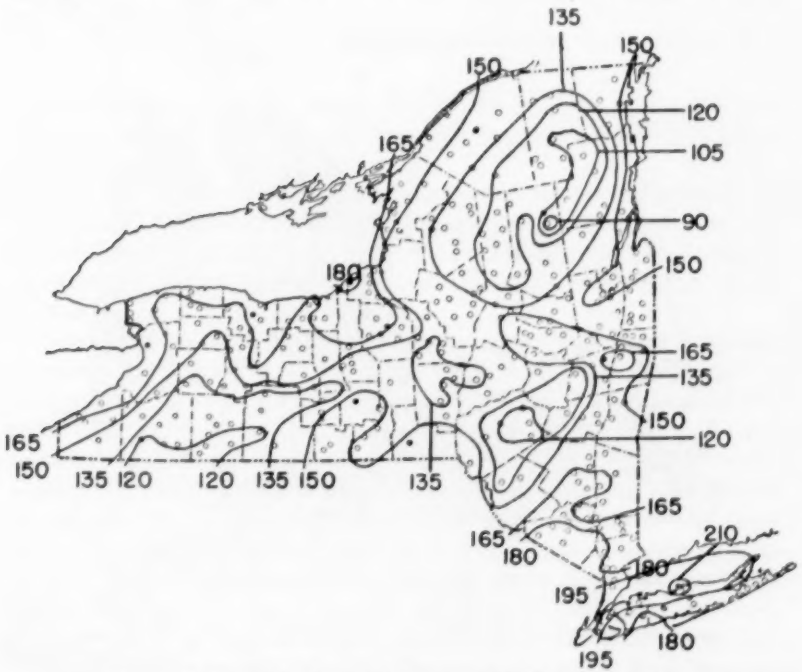


Figure 2. Length of growing season in New York State

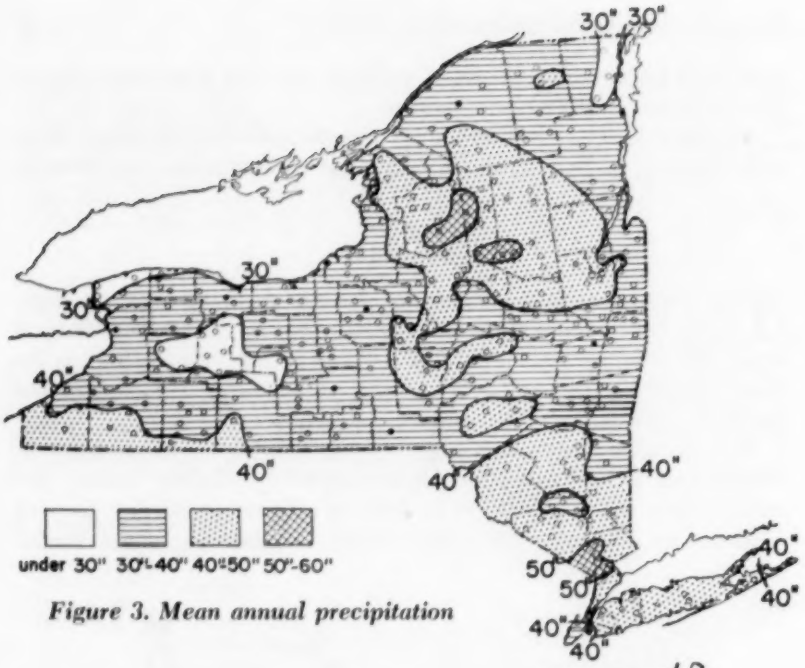


Figure 3. Mean annual precipitation

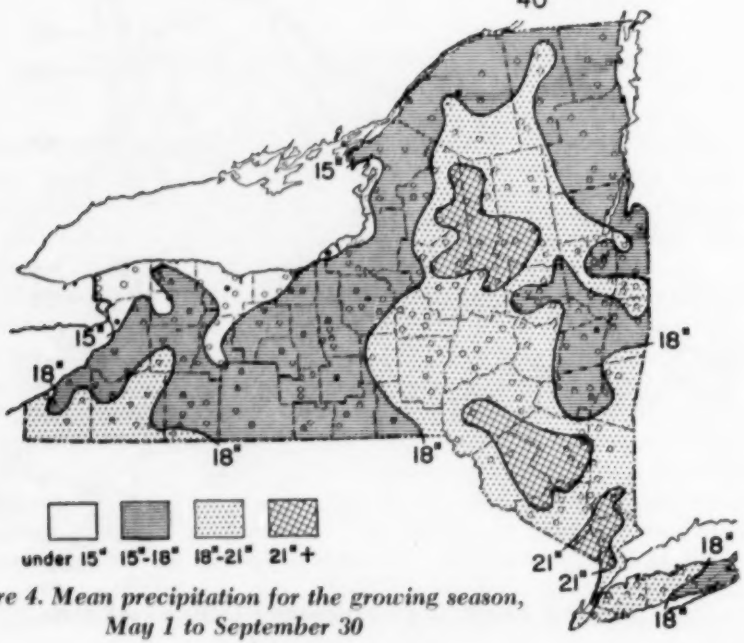


Figure 4. Mean precipitation for the growing season, May 1 to September 30

in length to that of much of the Allegheny Plateau in the south. The shortest growing season is in the center of the Adirondack highlands.

Mean annual precipitation is shown in figure 3, mean precipitation for the "growing season" in figure 4. Parts of the Erie–Ontario Plain and of the Champlain Valley are the driest parts of the State. The highland areas and the Mohawk Valley, the Hudson Valley, and the Long Island Coastal Plain among the lowland areas receive the highest total and growing-season precipitation.

You should keep in mind the fact that a cool climate and high precipitation favor the formation of soils called *Podzols,* which have a bleached, strongly leached, upper part over a subsoil in which iron combined with humus has accumulated. Warmer temperatures favor soils called *Gray-Brown Podzolic,* which have a less strongly leached upper part over a subsoil in which clay has accumulated. New York State is in a transition zone, climatically, between these two great soil regions.

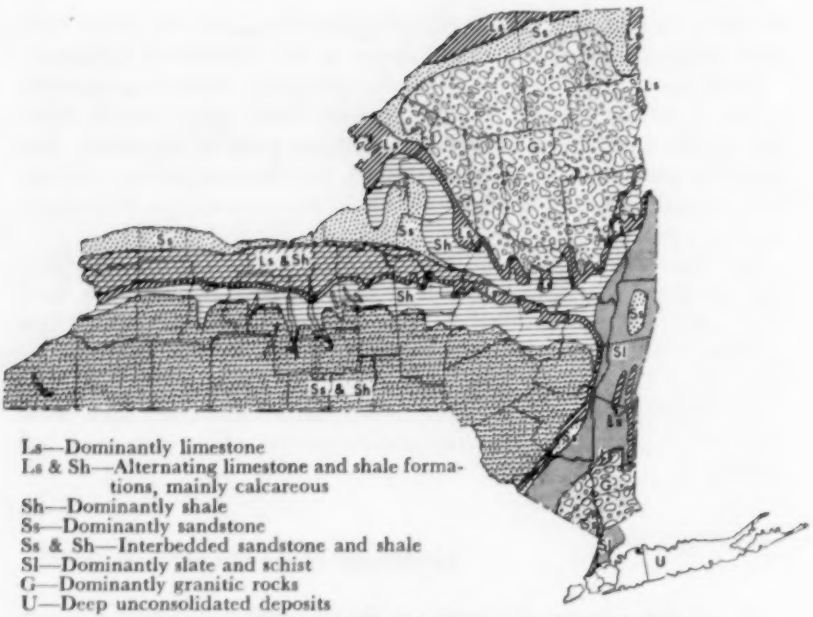
Bedrock

As THE bedrock was the source of the material from which our soils have formed, figure 5 will help you to understand the distribution of soils.

The areas of the Adirondack highlands and the New England Uplands have old ***granitic rocks*** which are very hard, high in coarse crytals of quartz, and very low in lime. The soil material from them is stony, sandy, and low in fertility, and the agriculture of these areas is poor.

Note the major areas of ***limestone.*** Remember that when limestone weathers, the lime in it is lost and the soils form from the impurities that were present. The limestone of the northern part of the St. Lawrence Valley is high in quartz sand and gives moderately sandy soil material. That in the Black River, Mohawk, and Champlain Valleys contains much "floury" impurities called ***silt*** and ***very fine sand.*** These limestones give medium-textured soil material called ***loam.*** The large area of limestone and shale and the belt of limestone south of it in western and central New York give similar loam or silt loam soil material.

There are two important ***shale*** areas, one in the Black River and Mohawk Valleys and the other on the northern edge of the Allegheny Plateau. Shales are rocks made up of very fine particles that leave



Ls—Dominantly limestone
Ls & Sh—Alternating limestone and shale formations, mainly calcareous
Sh—Dominantly shale
Ss—Dominantly sandstone
Ss & Sh—Interbedded sandstone and shale
Sl—Dominantly slate and schist
G—Dominantly granitic rocks
U—Deep unconsolidated deposits

Figure 5. Important bedrock areas of New York

clayey (heavy) material when they weather. The shales of both of these areas contain enough silt, however, to make their weathered products mainly only moderately fine-textured. In both areas, the shales are high in lime at the northern edge of the area but become lower in lime to the south.

Although the ***sandstone*** areas are not large, they contribute important soil material. Sandstone, made up of sand grains cemented together, leaves sandy material when it weathers. The sandstones of both areas (figure 5, Ss) contain little lime.

The sandstone and shale of the Allegheny Plateau and Catskill Mountains contributes a mixture of coarse and fine particles to give medium-textured soil material. There is more shale than sandstone in the western and northern parts and more sandstone than shale in the eastern and southern parts of these regions. Texture of soil material varies similarly within the area. Those rocks farthest north and west have the most lime. Locally in southern Cattaraugus and Allegany Counties and on the edges of the Catskill Mountains, the rocks are red and the soils in these places are reddish in color.

The ***slate*** and ***schist*** of the Hudson Valley and New England Up-

lands weathers to silty soil material. These rocks were once mainly shales but have been moderately altered by extreme pressure and high temperature. The weathered material is much like that from the shales.

Notice that bedrock is not shown for Long Island. Here there are very thick deposits of gravel and sand that completely obscure the bedrock.

Glacial Deposits

FORTUNATELY the soils you find today did not develop on rock material weathered in place. If they had, our soils would be very old and poor throughout much of the State. Almost everywhere in the State you will find soils in rock material that was ground fine, mixed, transported, and in some places resorted by ***glaciers*** and the melt water from them. The glaciers of New York melted away in relatively recent time as compared with the age of the bedrock, so New York soils are young and are forming in relatively fresh rock material. To understand the distribution of soils, therefore, you need to know what kinds of deposits the glacier left behind.

Visualize a time when temperatures were somewhat colder than today—cold enough so that all the snow of winter did not melt during the summer in the areas of Canada north of New York. Slowly the snow accumulated and turned to ice until a great dome of ice thousands of feet thick had accumulated. There are conditions like that today on Greenland. With all this weight of ice in the center, the edges were forced outward, and a great glacier pushed southward over New York State. Now imagine how these millions of tons of ice scraped up the soil, pulled hard rock loose, and ground the whole to fine pieces as it dragged the mixture southward. Look again at the map of bedrock and notice that the ice moved across these areas from north to south. The result was a mixing of rock material of adjacent areas and general transportation to the south.

Now think of the time when temperatures increased slightly and the glacial ice melted faster than it moved. As the ice front melted back, the glacier left behind the ground-up rock material as a mantle over the hills, valleys, and plains it had crossed. This heterogeneous mixture of stones, gravel, sand, silt, and clay deposited directly by the ice is called ***glacial till.***

Today there are belts of glacial till that correspond crudely to the belts of bedrock in figure 5 but are slightly to the south. These de-

posits grade gradually from one mixture of rock material to another instead of having sharp boundaries like those of the bedrock. You will find, for example, that the limestone of western New York was carried into the shale area to the south and mixed with shale. The amount of limestone in the till decreases from the limestone-shale boundary southward, and the amount of shale increases. Similarly, the calcareous shale was carried into the more acid sandstone and shale area to the south but decreases in the till with distance from the outcrop. Important soil distinctions due to these parent material differences are shown in the soil key on the back of the map and on the colored map of soil associations.

Effects of glaciation did not stop with deposition of glacial till. Think of the volume of water that must have poured from the ice front as the mountain of ice melted. Great rivers carried rock material from the ice, sorted out the fine particles, and carried them away. It rolled the gravel and sand down stream to be left as ***glacial outwash*** deposits. You will find these deposits of glacial outwash gravel and sand in all the valleys and along all the rivers that had an open outlet away from the ice front. The long areas colored yellow on the Allegheny Plateau section of the soil map represent soils on such deposits.

Now think of a valley whose stream flowed toward the ice, like the north-flowing Genesee. The divide on the south was a dam to the melt waters, and the ice on the north was another dam. The water formed a lake between these two barriers. Wherever fast-flowing rivers entered these lakes, they dropped the rock material they had carried. The sands were dropped first near the margins of the lake as ***deltas.*** The large areas colored yellow on the northern side of the Black River Valley represent soils from such sand deposits. The silts and clays were carried farther into the lakes, however, but eventually even they settled in still water to form ***lake-laid*** or ***lacustrine*** silt and clay deposits. The areas colored light blue on the soil map represent soils in such materials.

At the end of glacial time, the land surface was lower than it is today, and an arm of the sea extended up the St. Lawrence and Champlain Valleys. Clay and silt were deposited in this body of water as in glacial lakes. These deposits are called ***marine*** sediments because they were deposited in salt water.

You can imagine that during the time the ice was melting, the temperatures on the land adjacent to the glacier must have been very cold. Probably these areas were like parts of the arctic today, with freezing and thawing and general churning of the exposed glacial deposits by frost action. Shallow soils are found in broken and partly

pulverized rock material that was probably formed in this way rather than by the glacial ice itself. Geologists call this ***congelifractate*** or ***congeliturbate,*** but for purposes of this bulletin it is considered part of the glacial-till mantle.

Since glacial time, the streams of today have overflowed their banks and left sand, silt, and clay on the areas they covered. This material is called ***recent alluvium.*** It is the parent material of the very young soils of ***first bottomlands.***

Soils

Look at the side of a pit in the soil, and note the different kinds of layers from the surface downward. These layers differ in color, in the relative amounts of fine and coarse particles (*texture*), in the way these individual particles are held together in blocks, plates, or granules (*structure*), and in many other properties. These layers, called ***horizons,*** are usually the result of soil-forming processes, and soils that are formed in the same way have the same kinds of horizons arranged in the same order. Wherever the original material was of one kind and the forces of soil formation have been alike, you can expect to find similar kinds and arrangements of horizons. Soils that are alike in all of their horizons except texture of the surface soil belong to one ***soil series.***

Each soil series is given a name taken from a place near which the soil was first described. Notice on the soil-association map that Ontario soils are found in Monroe County between Lake Ontario and Ontario County. The Ontario series was named there in 1910. Some names used in New York came from places in New York, others from places in other States where similar soils are found.

To understand what these soil series are like, you need to know some of their more important properties. A few of these are given in the key on the back of the soil map. This key contains terms you may not know, so these are explained in the following paragraphs.

Soil Texture

Texture refers to the relative proportions of sand, silt, and clay particles. ***Sand*** is coarse enough for you to see the individual grains. ***Silt*** is too fine for you to see individual particles; it feels very floury but is not plastic. ***Clay*** is the finest of all and is the kind of particle that makes soil plastic when wet.

Coarse-textured soils are mostly sand or gravel, and you will find

them loose or at most only slightly coherent. Such soils normally hold little water or plant nutrients. They include *sand* and *loamy sand* textural classes.

Moderately coarse-textured soils are also high in sand, but they include enough silt and clay to hold the sand grains together when moist, retain appreciable water, and supply some plant nutrients. Such soils are somewhat drouthy where there is no water table near the surface and generally are low in fertility. They are cultivable soils if other conditions are favorable. They include the textural classes *sandy loam* and *fine sandy loam*.

Medium-textured soils have the best combination of coarse and fine particles for general agricultural use. They are mixtures of sand, silt, and clay, high enough in fine particles to hold water and plant nutrients but low enough to be easy to work and to keep in good physical condition. They include *very fine sandy loam, loam,* and *silt loam* textural classes.

Moderately fine-textured soils are sometimes called "strong soils", for they contain enough clay to give greater than average ability to supply plant nutrients. They are moderately sticky and plastic, tend to puddle if worked when too wet, and may form a crust on the surface if organic matter is low. They are more likely to have restricted internal drainage than are medium-textured soils. They supply water and nutrients well but are moderately difficult to keep in good tilth. They include the *clay loam, sandy clay loam,* and *silty clay loam* textural classes.

Fine-textured soils contain more than 40 percent of clay, and are very sticky and very plastic. They hold much water and plant nutrients, however; and, if kept in good tilth, can be productive of some crops. They are the most difficult of all to keep in good physical condition, and commonly have restricted internal drainage. They include the *sandy clay, silty clay,* and *clay* textural classes.

Soil Drainage

Soil-drainage classes used in the key to soil series give a picture of how often and for how long the soil is wet.

Excessively drained soils are commonly so drouthy that they are unsuited to ordinary crop production without irrigation. The soils lose most of the water that falls on them very rapidly and hold little for use by crops. The excessively drained soils are listed in the same column as the well-drained soils in the key, but you can identify them

as the coarse-textured or very shallow series. In the field, you will see strong colors free of mottling in the subsoil.

In ***well-drained soils,*** excessive water is removed readily, but the soil retains a large amount for plant growth. Soils of this drainage maintain the most nearly optimum amount of water that can be held for plants without restricting the growth of crops sensitive to short periods of wetness. In the field you will see uniform colors free of mottling throughout the profile.

In ***moderately well-drained soils,*** water is removed slowly enough that the soil is wet for a small but significant period of time. They are not dry enough to work until one or two weeks after well-drained soils are ready for tillage in the spring. You can expect better production in dry years than on well-drained soils but their use for water-sensitive crops, such as alfalfa and apples, is limited. Even these crops can be grown successfully if other conditions are favorable. If you examine the soils in the field, you will find uniform colors free of mottling, or with only faint staining in the upper 15 to 24 inches, but distinct rusty brown mottles at greater depth.

On the ***somewhat poorly drained soils,*** the choice of crops and the growth of adapted crops are restricted to a marked degree. Water is removed slowly, and the soil is wet late in the spring and for short to moderate periods in midsummer. Crops such as alfalfa and apples are very short-lived on these soils. Late-planted annual crops or water-tolerant crops may be productive. This is the poorest drainage suited to cultivation for crops other than hay or pasture without artificial drainage. In the field you will find these soils strongly stained and mottled with gray and rusty brown from the plowed layer downward.

The ***poorly drained soils*** are wet much of the time and are unsuited to crops other than hay or pasture unless some artificial drainage has been provided. Establishment of road ditches, dead furrows, and similar drainways has improved many areas enough to permit limited cropping without systematic drainage systems. Areas that have been adequately drained artificially may be highly productive if other conditions are favorable. In the field, you will find a surface horizon distinctly darker and more gray than that of better drained soils and a subsoil that has strong rust-brown mottling among dominantly gray colors.

On the ***very poorly drained soils,*** water stands on or near the surface most of the year if artificial drainage has not been established. Road ditches may have lowered the water table somewhat in some areas, but even most of these are too wet to crop. These soils have a

deep, black, surface soil high in organic matter and a gray-mottled subsoil.

In the key to soil series note that all soils listed on one horizontal line are derived from the same kind of material but differ in drainage. These soils listed horizontally form a group known as a ***Catena.*** This is one of the most useful ways to show soil relationships within small areas, because it shows the soils that are commonly found side by side within a field or within a farm and also shows one of the most important differences among them.

Soil Acidity

Soil acidity is one of the most important problems of crop production in New York. Acid soils generally are low in calcium and magnesium, which are needed by plants. Probably more important, however, they make phosphorus unavailable, contain soluble iron and aluminum which are toxic to many crops, and limit the activity of microorganisms that release plant nutrients such as nitrogen. Organisms that live on the roots of legumes and convert nitrogen of the air to forms that plants can use are most inefficient in strongly acid soils. Some crops, such as legumes, are very sensitive to soil acidity, and most crops produce best on soils that are not strongly acid. Lime is applied to correct both acidity and the undesirable conditions associated with it.

Soil acidity is expressed on a scale called *pH;* but in this bulletin, descriptive terms that stand for a definite pH range are used as follows:

Extremely acid	pH less than 4.5	*Medium acid*	pH 5.6 to 6.0
Very strongly acid	pH 4.5 to 5.0	*Slightly acid*	pH 6.1 to 6.5
Strongly acid	pH 5.1 to 5.5	*Neutral*	pH 6.6 to 7.3

You can buy a simple testing kit to test your soils for acidity and lime requirement. Where acidity is indicated for soils described in this bulletin, it refers to the unlimed soil. You should test the soil yourself or submit samples through your County Agricultural Agent to determine lime needs at any given time.

Neutral soils are best for most crops. Soils that are neutral throughout need no lime, and those indicated as neutral in this bulletin are not likely to become acid quickly under cropping. On ***slightly acid soils,*** crops may produce well without liming, but legume forage crops,

especially alfalfa, are likely to be short-lived. ***Medium acid soils*** limit production and persistence of all the forage legumes and restrict yields of most of the crops commonly grown in rotations with them. You will find ***strongly acid soil*** the most common condition of unlimed fields outside the areas affected by limestone and calcareous shale. Most of the general farm crops respond well to liming, and legume seedings are largely wasted without liming on such soils. The problem is even more acute on ***very strongly acid*** and ***extremely acid soils.***

Many soils that have medium- or strongly acid plow layers have lime in the substratum. These conditions are indicated by special terms. ***High-lime soils*** have neutral to slightly acid upper parts, but acidity decreases with depth and most have free lime at 18 to 30 inches. Such soils need little lime and may need none. ***Medium-lime soils*** have strongly acid upper parts to depths of more than 12 inches, but acidity decreases with depth. Lime is commonly found at depths below 30 or 40 inches. You can expect such soils to need as intensive liming as those with no lime in the substratum, but deep-rooted crops may benefit from the substratum lime if the soils permit deep rooting. ***Low-lime soils*** are strongly or very strongly acid to depths greater than 30 inches but have neutral material or free lime deep in the substratum, commonly beyond the reach of roots. Horizons that contain free lime are said to be *calcareous.*

Fragipan Horizons

In a very high proportion of the acid soils from glacial till, you will find a horizon in the deep subsoil that is very tightly packed and slowly permeable to water. The pores are small, and the horizon holds so little water available to plants that few roots develop in it. This horizon is called a ***fragipan.*** In the well-drained soils, you will commonly find fragipan at depths ranging from 18 to 30 inches, and it extends downward to depths of 4 to 7 feet. As drainage becomes poorer, the horizon is more strongly expressed and at shallower depth. In poorly drained soils, the top of it is only 12 or 15 inches below the surface.

This horizon has resulted in the development of very large acreages of somewhat poorly drained soil throughout the acid soil regions. It retards downward movement of water, causing seepage down hill and somewhat poor drainage on even strongly sloping areas. A high proportion of the drainage problems of the State are related to this pan, and these are the areas where improvement of drainage is costly and difficult to establish.

Fragipans are not present in very sandy soils, very clayey soils, or calcareous material. Coarse texture, fine texture, and lime seem to prevent their formation. They are in a high proportion of the medium- to moderately coarse-textured soils of the Acid Brown Earth and Podzol groups, which are described in the following paragraphs.

Major Kinds of Well-Drained Soils

If you travel over the State, you will see the same general kinds of soil profiles repeated over and over on the well-drained sites within a given region. Texture, the kinds of rocks, and other properties may vary, but horizons are of the same kind and in the same sequence. The forces of climate and vegetation of a region cause the same general kind of soil formation.

There are only eight of these very broad kinds of well-drained soils. To know what they are like will help you to understand the soils of the State—their relationships and their differences as given in the key to soil series.

Alluvial Soils are very young. They are found where rivers in flood overflow their banks and leave fresh sediments almost every year. If you look at them on the first bottomlands of the larger rivers, such as the Genesee, you will see only two distinct horizons as in figure 6. The plowed layer is dark colored because of an accumulation of organic matter from the roots and tops of plants. The subsoil is dull-colored, like the fresh alluvium deposited at the last flood. Soils like this are the most fertile among those of similar texture, for leaching has been very slight and the nutrients in the original material are still present.

Brown Forest Soils represent the second stage of development, but they are still young soils high in fertility for their texture. You will find them on the most highly calcareous glacial deposits in the northern areas where the ice melted last. On these soils, lime has preserved the minerals against weathering and leaching while plants have built a thick surface layer rich in organic matter. If you examine these soils, you will see three main horizons as diagramed in figure 6: (1) a thick horizon of organic matter accumulation, (2) a brown partly weathered horizon still rich in plant nutrients, and (3) calcareous nearly unweathered material at shallow depth.

Gray-Brown Podzolic Soils represent the third stage of soil development on calcareous material throughout most of the State and are also found on originally acid material in the warmest parts of the Ontario Plain. Weathering has proceeded to greater depth than in Brown

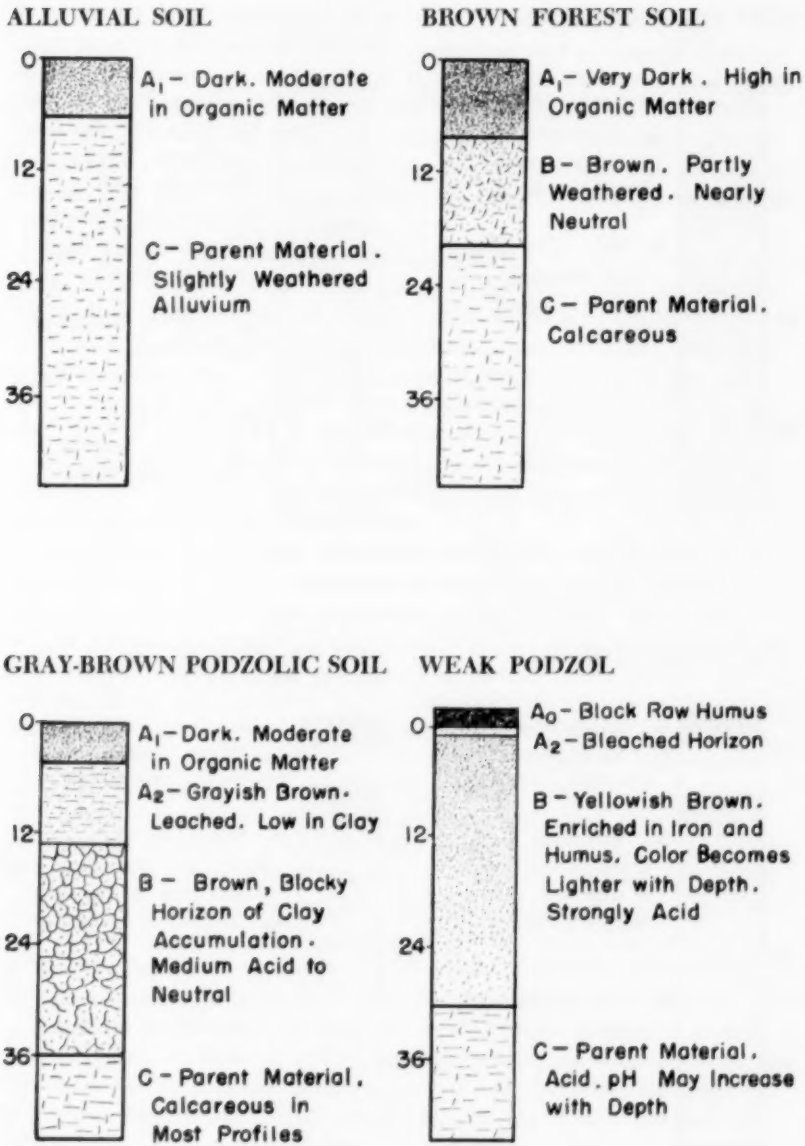


Figure 6. The horizon sequence in Alluvial Soils, Brown Forest Soils, Gray-Brown Podzolic Soils, and weak Podzols

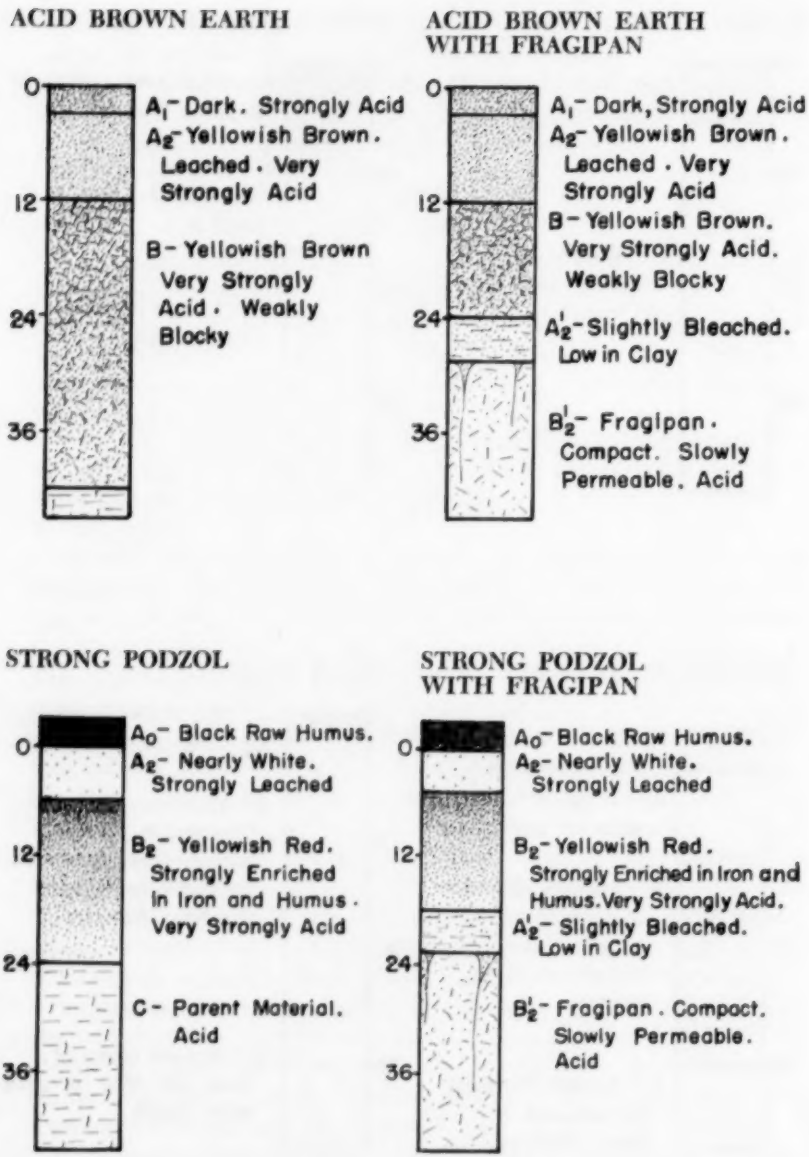

ACID BROWN EARTH
0
12
24
36
A1 - Dark. Strongly Acid
A2 - Yellowish Brown. Leached. Very Strongly Acid
B - Yellowish Brown Very Strongly Acid. Weakly Blocky
ACID BROWN EARTH WITH FRAGIPAN
0
12
24
36
A1 - Dark, Strongly Acid
A2 - Yellowish Brown. Leached. Very Strongly Acid
B - Yellowish Brown. Very Strongly Acid. Weakly Blocky
A'2 - Slightly Bleached. Low in Clay
B'2 - Fragipan. Compact. Slowly Permeable. Acid
STRONG PODZOL
0
12
24
36
A0 - Black Raw Humus.
A2 - Nearly White. Strongly Leached
B2 - Yellowish Red. Strongly Enriched in Iron and Humus. Very Strongly Acid
C - Parent Material. Acid
STRONG PODZOL WITH FRAGIPAN
0
12
24
36
A0 - Black Raw Humus.
A2 - Nearly White. Strongly Leached
B2 - Yellowish Red. Strongly Enriched in Iron and Humus. Very Strongly Acid.
A'2 - Slightly Bleached. Low in Clay
B'2 - Fragipan. Compact. Slowly Permeable. Acid

Figure 7. The horizon sequence in Acid Brown Earths and in Podzols with and without fragipans

Forest Soils (figure 6), the upper part is moderately leached, and clays have been removed from the upper part and accumulated in the third horizon. Except on the sands, these are still moderately to highly fertile soils and you can expect them to be highly productive of a large number of crops. The clays accumulated in the subsoil provide a reserve of plant nutrients, especially potash, and hold water for plants. This tends to compensate for leaching of the upper horizons, which range from slightly to strongly acid.

Acid Brown Earths are very strongly leached and deeply weathered soils. They are mainly in the Hudson Valley and locally on the Ontario Plain. They are restricted to the warmest parts of the State where oaks were prominent in the original forest. These soils have four principal horizons (figure 7) like the Gray-Brown Podzolic soils but the soil is more strongly leached, generally more acid, and lacks the distinct clay accumulation in the third horizon. Although Acid Brown Earths are low in fertility, the deep, medium-textured, well-drained soils of the group are highly productive of a large number of crops when adequately limed and fertilized.

Acid Brown Earths with Fragipans are like the Acid Brown Earths to a depth of 18 to 24 inches, but have a dense horizon slightly enriched in clay and slowly permeable to water below that depth. A higher proportion of soil has restricted drainage in these areas, but in other respects they respond to cropping like the Acid Brown Earths without fragipans. The well- and moderately well-drained soils are potentially productive, but require heavy liming and fertilization.

Podzols are very strongly acid soils in which iron has been removed from the upper mineral layer, leaving a nearly white, bleached zone. The iron has been deposited with humus to form a brilliant yellowish-red subsoil. Raw humus accumulates on the surface under the forest above the bleached horizon (figure 7). You will find all degrees of development of these horizons in the State, ranging from soils with ½-inch bleached horizons to some in which the white horizon is more than 12 inches thick. Generally, the strength of development increases from warm to cool climate and from medium to coarse textures.

Notice the difference between the weak Podzol of figure 6 and the strong Podzol of figure 7. Soils like these are separated in the key. If the weak Podzol is plowed, the humus layer, the bleached horizon, and the upper part of the iron accumulation are mixed, and the soil looks like an Acid Brown Earth thinner than normal. It behaves somewhat like an Acid Brown Earth under cropping, but is in a cooler region with more limited crop adaptation. With intensive fertilization and liming, it can, however, be very productive of adapted crops. In con-

trast, the strong Podzols normally retain stronger evidence of their character under cultivation. You will find them in even cooler areas with more limited crop adaptation. They are even lower in fertility than the weak Podzols and fix exceptionally large amounts of phosphorus in forms that plants cannot use. On medium-textured material, with other conditions favorable, even the strong Podzols can be productive of adapted crops, but they produce little without heavy fertilization and liming. Both weak and strong Podzols release potash much more slowly than Gray-Brown Podzolic soils of similar total potash content.

Podzols with Fragipans are like the Podzols to depths of 15 or 20 inches, but they have very dense, slowly permeable horizons below the Podzol part. This fragipan is associated with the very large acreage of somewhat poorly drained soil in the Podzol areas of the State. Where texture and drainage are comparable, the problems and limitations of these soils are similar to those of the normal Podzols. You can expect a much smaller acreage of well-drained soil where the fragipan is present, however. The fragipan may be present in either weak or strong Podzols.

Key to the Soil Series of New York

To locate a given soil series in the key on the back of the soil map, refer to the index that follows the table. The soils are listed alphabetically in the index, and the number of the line on which the series is classified in the table is given. Turn to this line in the table and find the series in one of the five columns on that line.

After locating the series in the table, you can learn some of its most important properties from the key in the left column. Start with the item listed A, B, C, or D. Then follow the successive items that apply to the series. These are indented stepwise, and the successive steps are identified by the following numbers or letters: Capital letters, A, B, C, or D; numbers, such as 1, 2, or 3; small letters, such as a, b, or c; numbers in parenthesis, such as (1), (2), or (3); and small letters in parenthesis, such as (a), (b), or (c). For example, you may follow items A, 1, a, (1), and (a) to the line on which the Pittsfield series is listed.

These items tell you first the general kind of parent material from which the soil has developed—glacial till, sorted gravel or sand, lake-laid sediments, or recent alluvium. These materials are described on pages 11 to 13. Starting with this information, you can build up, step by step, a picture of the outstanding properties of the series.

The key gives you the kind of profile of the best-drained soil of the line on which the series is listed. This gives you a picture of the kinds of horizons as shown in figure 6 or 7 for the series itself or, if it is poorly or very poorly drained, for its most intimate associates. Texture of the profile is ***medium*** unless the key shows it to be otherwise, and depth to bedrock is normally more than 24 inches unless the key shows it to be shallow. Other features, such as acidity, kind of rock material, or color, are given if necessary to separate the series from a close relative or if outstanding in importance and not inferred from the kind of profile.

The features in the key apply to the best-drained soil on the line. Next notice the heading of the vertical column in which the soil is listed. This gives you the drainage condition, and the section on drainage classes (page 14) tells what each drainage class means. Add these conditions and properties to the picture of horizons, texture, acidity, and the like that you have established for the well-drained soil. If the series is poorly or very poorly drained, its horizons may differ markedly in color and associated properties from those of the well-drained soil, but characteristics such as texture still apply.

Each series is listed between two short vertical lines. These lines mark the drainage limits within which the series is defined. In a number of cases, you will notice an *arrow* extending from one of these limits into the column of a better or a less well-drained class. These arrows indicate that an unnamed soil, commonly of limited extent, occurs and is included with the series in mapping. In some cases the word *unnamed* is inserted in parenthesis (unnamed) where a new series is known to be needed but has not yet been named. A *blank* space in a drainage column means that a soil of this kind is not known to exist or is so small in area that it does not justify recognition.

The placement of soils in this table applies to the way in which each series is to be used in mapping now in progress. You will note instances in which a soil name with which you are familiar is defined more narrowly than it was used in the past. This is the result of refinement in mapping criteria as a consequence of learning more about the significance of certain soil properties or of the change from small-scale to large-scale maps. On the older maps made at a scale of 1 inch to 1 mile, it was impossible to separate all the soil conditions significant for farm planning. The map units at this scale were defined broadly to give a mappable unit. For example, only three drainage conditions were recognized. When mapping at 4 inches to 1 mile began for farm planning, it was necessary to define the units more narrowly and to

show more features as well as finer differences. Consequently, the soil series are now defined to cover a narrower range, and more series are recognized.

Soil Associations

ON THE pages that follow is a brief description of each kind of area shown on the soil-association map. Notice that these areas are large. They were outlined as large areas purposely in order to deal with the soils of whole communities. This means, however, that each area contains more than one kind of soil, because highly contrasting soils are commonly intimately associated within small areas, such as a single farm. This is the reason that the areas are called *soil associations. They are areas within which you will find two or more different soils that characteristically are side by side within a single field or a single farm.*

You will notice that the name of each soil association is made up of the names of the dominant soil series of the area. In some areas, one soil series is so extensive that only one name is used. The Hoosic association is an example. In many areas, two intimately associated series are extensive, so both series names are used with a dash between them. The most extensive series is listed first, as, for example, the Ontario-Hilton association. When two or more names are used with commas or the word "and," such as *Alton, Colosse,* and *Ottawa* associations, each name used stands for a separate and distinct kind of area. These areas are, however, enough alike so that they are not identified separately on the map nor discussed separately in the bulletin.

The description of each soil association is in two parts for your convenience. The first part tells you the outstanding features of the landscape as a whole, the names, and a few important properties of the dominant soils, the relative proportions of these soils, and where you should expect to find them in the landscape as a whole. The most common of many soils of small extent, which you may or may not find in any given area, are also listed. The second part tells you the general quality of the area for agriculture, the general crop adaptations, and the outstanding management problems, including liming, fertilization, drainage, and erosion control.

Those of you who need to identify the individual soils within a field or a farm should use the detailed soil maps made on aerial photo-

graphs if they are available. Inquire at your local Soil Conservation District or County Agricultural Agent's office. If these maps are not available, the catena key and the brief reference to the topography of the dominant soils will help you to identify some of the most important soils.

Most of the soil associations are dominated by soils of one catena. A few have nearly equal proportions of two catenas. The key to soil series tells the drainage and a few important properties of the series in each catena. The description of the soil association tells you the topographic position on which you can expect to find the dominant soils, using the terms described in the following paragraphs.

If a soil is on a ***convex slope,*** look for an area whose surface is shaped like one side of a Quonset roof. It may be steep or very gently sloping, but the slope gradient increases as you go down hill. Water flows faster the farther it goes on slopes like this, and the soils are almost always well- or moderately well-drained. If the soil is on a ***uniform slope,*** look for a surface like one side of a gable roof. The slope gradient remains the same as you go down hill. The lower parts of long, uniform slopes commonly accumulate excess water and have somewhat poorly drained soils unless the material is rapidly permeable or the slope is steep. If the soil is on a ***concave slope,*** look for a surface like one side of a tent whose guy ropes are slack. The slope gradient decreases as you go down hill. Water concentrates on slopes like this because rate of runoff decreases as the water flows down hill. Such slopes commonly have poorly or somewhat poorly drained soils on them. Saucer-shaped areas are ***depressions*** and commonly have very poorly drained soils. Areas that are level, like a floor, are called ***flats*** and commonly have poorly drained soils if the soil and substratum are not loose and porous.

You should have no difficulty in recognizing ***nearly level*** areas. Such areas fall less than 3 feet in a distance of 100 feet, have slow runoff, and are ideal for the use of machinery. On ***gently sloping*** and ***undulating*** areas, you can see a distinct slope; but the slope is not enough to interfere appreciably with the use of the heaviest types of machinery. Both fall from 3 to 8 feet in a distance of 100 feet, which is enough to permit runoff of excess water. Gently sloping areas have single slopes in only one direction, like a roof with a very gentle pitch. Undulating areas consist of a series of low knolls with complex slopes in more than one direction.

When the terms ***sloping*** and ***rolling*** are used, think of areas where you could use heavy machinery but with considerable difficulty. Ma-

chines tend to slip down hill, and it is hard to turn a good furrow up hill on such slopes. Both fall from 8 to 15 feet in a distance of 100 feet. Sloping areas have a single slope in only one direction, whereas rolling areas have many distinct knolls that slope in many directions. Rolling areas are more difficult to work than sloping areas.

When the terms ***moderately steep*** and ***hilly*** are used, think of areas where you would not dare attempt to drive on the contour with a load of hay. You would have to drive either straight up hill or straight down hill to prevent tipping. Both of these kinds of slopes fall from 15 to 25 feet in a distance of 100 feet. Moderately steep areas have a single slope in only one direction, whereas hilly areas consist of small hills that slope in many directions. ***Steep*** areas fall more than 25 feet in a distance of 100 feet and are rarely cultivated in New York.

For easy reference, the soil associations of the State are described in alphabetical order of their map symbols in the following pages. In the legend on the map, however, they are grouped under headings that indicate some of the outstanding similarities and differences among them.

Alton, Colosse, and Ottawa Associations—Soils of these associations are on nearly level areas of gravel or sand deposited as glacial outwash terraces, deltas, and beaches. The somewhat drouthy, strongly to medium acid Alton soils on gravel deposits or the more drouthy, strongly acid Ottawa soils on sand deposits are found mainly west of Rochester. The drouthy, very strongly acid Colosse soils on gravel are mainly east of Rochester. One of these three nearly level soils occupies from 60 to 80 percent of most areas and dominates land use. Locally in western New York some of the sands are underlain by clay—these sands are less drouthy than normal. The somewhat poorly to poorly drained soils of the Alton, Colosse, or Ottawa catenas may appear as minor constituents in low-lying flat areas. Moderately well- to poorly drained soils from glacial till may appear also as local inclusions.

Deep-rooted crops, early vegetables, and early-maturing small fruits are most productive on soils of these associations. Tree fruits are exceptionally well adapted to the Alton soils where climate is favorable. Moderately low water-holding capacity of the dominant soils limits the yields of most shallow-rooted crops that mature late. Yields of all field crops are low unless the soils receive lime and fertilizer liberally. Nitrogen, phosphorus, potash, and lime are deficient. Crops on these soils are most responsive to fertilization during wet years or when supplemental irrigation is provided.

AA **Aurora–Angola Association**—In this association, the soils are low in lime, moderately well- to poorly drained, and shallow over shale bedrock. On the gently sloping or nearly level areas are the poorly drained, moderately fine-textured, shallow Angola soils. They occupy from 30 to 50 percent of most areas. On the more strongly sloping parts are the equally fine-textured and shallow but moderately well- to somewhat poorly drained Aurora soils that occupy from 30 to 50 percent of the association. Locally, these series are replaced by the Hornell and Allis soils, which are similar but overlie acid shales. In some places, moderately extensive areas of Erie soils may appear as inclusions.

Yields of most crops are poor on the soils of this association because of shallowness, poor structure, and low fertility. Where the depth to shale is 20 inches or more and the Aurora soils are dominant, fair yields of corn, small grains, and hay can be obtained with adequate liming and fertilization. Grapes are successful in some areas, but deep-rooted crops, such as alfalfa, are generally poor. Probably lime, phosphorus, potash, and nitrogen are deficient. Erosion is a serious problem wherever the soil is bare or supports poor vegetation due to low fertility. Most areas support poor agriculture or are abandoned.

Ah **Alton, Colosse, Hinckley, and Colton Associations, Hilly Areas**—Soils of these associations are on gravel deposits that have very uneven hilly topography. Very coarse texture, low water-holding capacity, low fertility, and uneven hilly relief are characteristic of all three associations. The soils listed in the name occupy from 75 to 90 percent of their respective areas. These excessively drained soils are on hills steep enough to make cultivation difficult. In the low flat areas between the hills are the poorly drained soils from gravel. Small areas of soil from glacial till may appear as local inclusions.

Where better soils of adjacent areas are available for cropland, these associations may be used for pasture. Locally the least hilly parts may be cropped. Most areas are idle or forested, however, for the soils are so drouthy and low in fertility that yields are usually poor.

Ap **Alps Association**—This association is a small area on the slopes of the "grit plateau" of Rensselaer County. There red soils developed in glacial till that is high in the red shale of the locality. The upper part of the soil is porous and acid but overlies a very compact fragipan that is netural in reaction. On the gently sloping uniform parts, the somewhat poorly drained, medium-

textured Alps soils occupy from 50 to 80 percent of the area. On the convex knolls and moderately sloping areas are the moderately well-drained soils that occupy from 10 to 25 percent of the association. The poorly drained soils on the flats and in the concave depressions occupy from 5 to 20 percent of the area. The moderately well- and poorly drained soils have not been named.

Potentially the dominant soils are moderately productive of a limited number of crops, mainly those grown in support of dairying, but yields are low unless the soil receives applications of lime and phosphorus. Crops on many fields are yellow due to lack of nitrogen as a result of poor stands of legumes in the sod crops. On most farms, restricted soil drainage limits agricultural use of these soils and artificial drainage is difficult to establish because of the pan horizon. There is little erosion in the area, but it could be a serious problem under intensive cropping. In most parts of the area, stoniness may be only a slight problem but in others it severely interferes with crop production.

Bf **Bridgehampton[2] Fine Sandy Loam Association**—These are areas of nearly level to gently undulating topography well suited to cultivation, but a moderately high proportion is idle land. The dominant soils have only a moderate thickness of material with good water-holding capacity over loose gravel. On 50 to 75 percent of the area is the somewhat drouthy Bridgehampton fine sandy loam. In some places Bridgehampton loam, which has a thicker finer-textured subsoil and better water-holding capacity, is found in moderately large areas. This soil occupies about 20 percent of the association. Locally, extremely drouthy, very coarse-textured soils, such as the Colton and Adams series, may appear as inclusions.

Low water-holding capacity and low fertility are the outstanding soil problems throughout most of the area. Where supplemental irrigation is provided and intensive fertilization is practiced, yields of potato and vegetable crops are good. The idle areas are without supplemental irrigation and are mainly those soils thinnest over gravel. The areas of Bridgehampton loam and some areas of the fine sandy loam that are deepest to gravel may be cultivated successfully without supplemental irrigation. All of the soils are very strongly acid and deficient in potash, phosphorus, and nitrogen.

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[2] Bridgehampton of this association was formerly included in the Sassafras series. The name *Bridgehampton* is used tentatively in this bulletin. The associated Podzols were formerly called *Dukes* and *Lakewood*.

Bl **Bridgehampton[3] Loam Association**—This association, dominant in the principal potato-producing areas of Long Island, is a nearly level to gently undulating area of loamy or silty soils with good water-holding capacity over gravel deposits. The productive Bridgehampton loam and silt loam soils occupy from 60 to 80 percent of the total area. These are well-drained soils with good water-holding capacity on gentle topography. Locally on similar topography there are more sandy soils, such as Bridgehampton fine sandy loam, and small areas of strong Podzols comparable to the Colton and Adams soils. The Bridgehampton fine sandy loam may be cultivated, especially if supplemental irrigation is practiced, but the Colton- and Adams-like soils are too drouthy for agricultural use.

This association supports an intensive agriculture in which potatoes are the dominant crop, in spite of initially very strong acidity and a low supply of phosphorus, potash, and nitrogen. The soils have good water-holding capacity, which accounts for the high response to the intensive fertilization commonly practiced. This intensive cropping and fertilization has resulted in loss of organic matter and nitrogen but in an increase of phosphorus throughout much of the area. Although the soils have good water-holding capacity, supplemental irrigation has improved production on some farms.

BL **Bath–Mardin–Lordstown Association**—These areas are broad, gently sloping remnants of a high plateau that is cut locally by steep-sided valleys. On the plateau summits, the soils are mainly well- to moderately well-drained. They are very strongly acid, of medium texture, and have a very dense fragipan horizon below 15 or 20 inches. On the convex, moderately sloping areas of these summits are the well-drained Bath soils. They occupy from 20 to 40 percent of the association. On the slightly convex but less strongly sloping areas are the moderately well-drained Mardin soils that account for from 20 to 40 percent of the association. The somewhat poorly drained Volusia soils on associated areas that receive runoff and seepage from higher-lying land may occupy from 10 to 30 percent of the association. On the steep valley sides are the well-drained, medium-textured, shallow Lordstown soils with soil profiles like those of Bath in the upper 20 inches but with bedrock in place of the fragipan below that depth.

Most of these areas are difficult to reach from the main roads and

[3] The Bridgehampton of this association includes the original Bridgehampton soils as well as soils thinner over gravel that were formerly known as Sassafras loam.

villages, which are mainly in the valleys. This has contributed to abandonment of some areas, although the soils are potentially productive. Potato production on a large scale has developed on some of these formerly idle areas. In the areas that are farmed, the deep soils are dominantly well suited to crops in support of dairying and to cash crops, such as potatoes, that are adapted to the cool climate. Yields, however, are low where lime, phosphorus, and potash are not applied liberally, although the dominant soils are potentially productive under good management. Drainage is a problem only locally in the small depressions and on small flat areas. Erosion may be serious where strongly sloping areas have been used intensively for intertilled crops. The association is made up of potentially very productive, deep soils on the plateau summits intermingled with rather large areas of shallow, steep soils best suited to forestry.

BM **Brayton–Moira Association**—Soils of this association are on long gentle slopes from the Adirondack highlands to the St. Lawrence lowlands where weakly calcareous glacial till, mainly from sandstone, dominates. The principal soils have a very dense fragipan, and during wet weather water accumulates above this pan to make the dominant soils somewhat poorly drained. The medium-textured, strongly acid, somewhat poorly drained Brayton soils are on the uniform gentle slopes. Brayton occupies from 25 to 50 percent of the association. On the slightly convex, moderately sloping areas where slope improves the drainage, is the moderately well-drained Moira, which occupies from 20 to 40 percent of the association. The poorly and very poorly drained soils of the same catena on the small flat areas and in concave depressions occupy from 5 to 20 percent of the association. The well-drained Parishville, local areas of the more acid Empeyville, and Colton-like soils in gravel deposits are minor inclusions. About 20 percent of the area is too stony for cultivation.

Although cool climate and restricted soil drainage limit the choice of crops, these areas are capable of fair production of adapted crops if fertility needs are satisfied. Corn for silage, small grain, and hay are grown almost exclusively. Alfalfa is limited to Moira or better-drained soils. Stands of legumes in hay fields are poor and yields of crops generally are low where lime, phosphorus, and potash are not supplied liberally. Crops are yellow, indicating nitrogen starvation, where legume stands are poor. Drainage is an important problem and one that is difficult to solve because of the pan in the subsoil. There is little evidence of erosion in these areas.

C **Colton and Adams Associations**—The Colton association is on undulating or nearly level glacial outwash terraces of gravel from sandstone or granitic rocks. The Adams association is on sands of similarly nearly level or gently sloping areas, but these are deltas that formed in ancient lakes. The very drouthy Colton soils in gravel or the Adams soils in sand occupy from 60 to 90 percent of the area and dominate land use. Both soils are on undulating to nearly level areas well above the streams of the locality. The moderately well-drained, sandy Croghan or gravelly Duane, the somewhat poorly drained, sandy AuGres or Saugatuck, or the poorly drained, sandy Scarboro series, depending upon the height above the water table, are on low-laying, flat areas. In the areas of this association on Long Island[4], there may be some moderately large inclusions of Bridgehampton fine sandy loam.

These areas are mainly non-agricultural because of their low water-holding capacity. In addition, the soils are very strongly acid and are very low in both phosphorus and potash. On the few cropped areas, response of general farm crops to lime and fertilizer is limited by low water-supplying capacity. Wind erosion is a serious problem in some areas. Where vegetation has been destroyed, the sands shift with the winds and form dunes.

CC **Caneadea–Canadice Association**—This association is on the lower slopes of the valleys in western New York where local lakes once stood between the valley divide to the south and the glacial ice to the north. The dominant soils are from clays and silts deposited in these lakes. The moderately well- to somewhat poorly drained clayey Caneadea soils are on uniform to slightly convex, gently sloping or sloping topography. Caneadea occupies from 40 to 70 percent of the association. On the nearly level to gently sloping areas is the equally fine-textured but poorly drained Canadice which occupies from 20 to 40 percent of the area. In low-lying depressions are small areas of the very poorly drained Lorain soils. Well-drained gravelly soils on terraces and somewhat poorly drained soils on glacial till are among the more important inclusions.

Restricted drainage, poor structure, and low fertility are outstanding problems. The crops of the area are limited almost entirely to corn, small grains, and hay; vegetable crops and deep-rooted crops, such as fruit and alfalfa, do poorly. Lime and phosphorus are uniformly

[4] The gravelly soils were formerly called *Dukes* and the sandy soils, *Lakewood* on Long Island.

needed, but response to potash is variable from place to place. Although organic matter appears to be high, the crops are yellow in many fields. This yellowing indicates a lack of nitrogen. Legumes, which supply nitrogen, are difficult to maintain, and nitrogen of the organic matter is released slowly. Poor drainage limits the yield of legumes, and the heavy soils are difficult to drain. Although there are few prominent signs of severe erosion on the dairy farms of these areas, the soils are very erodible, even on gentle slopes, when they are bare of vegetation.

CCo **Claverack–Colonie Association**—This association is in the sandy areas of the Hudson Valley. Clay underlies the sand at variable depths. The moderately well-drained, strongly acid Claverack soils are on nearly level areas where the sand is only from 18 to 36 inches thick over clay. Claverack occupies from 50 to 75 percent of most areas. On level to hilly areas that lie above the general level of the Claverack are the somewhat excessively drained, very strongly acid Colonie soils. They occupy from 15 to 30 percent of the association. Poorly drained soils from clay or somewhat poorly drained soil in thin deposits of sand over clay are on some of the flat areas.

The association is a complex of two contrasting soil conditions. The low-lying Claverack soils have restricted drainage and are moderately low in fertility. The associated Colonie soils are somewhat drouthy and are even less fertile. General farm crops and vegetables are very productive on the Claverack soils if they are adequately fertilized. These soils are very strongly acid and are very low in lime, potash, and phosphorus, but are responsive to fertilization and liming. The associated Colonie soils are even lower in fertility and require supplemental irrigation for even fair response to fertilization.

CCM **Cattaraugus–Culvers–Morris Association**—This association of reddish colored soils occupies the broad till-mantled hills of the Allegheny plateau where glacial action has mixed red and gray shale and sandstone. The dominant soils are very strongly acid and low in fertility, but have good water-holding capacity above a very compact fragipan. On distinctly convex slopes where runoff improves drainage is the well-drained Cattaraugus soil, which occupies from 30 to 50 percent of the association. The moderately well-drained Culvers is on less strongly sloping but still convex topography. Culvers accounts for from 20 to 40 percent. The somewhat poorly to poorly

drained Morris soils are in depressions and in small concave areas on slopes. The shallow Oquaga or Lordstown and the very poorly drained Norwich soils may appear as minor constituents. About one-fifth of the area is too steep for cultivation, and the potential cropland ranges from gently sloping to sloping.

This association is among the more productive areas of the hill lands of southern New York. The dominant soils have good water-holding capacity and are at least moderately well drained. Corn, small grains, and hay are the most common crops, although cash crops, such as potatoes and peas, are adapted. Some alfalfa grows where the soils are adequately limed and fertilized. The differences between the inferior crops on farms where little lime and fertilizer are used and the very good production obtained on farms with adequate liming and fertility programs are striking. Lime and phosphorus are uniformly deficient and the need for potash increases as yields are increased by other good management practices. Erosion is not conspicuous where sod crops are prominent, although slopes are steep enough to make it a potential problem on most farms.

CD **Collamer–Dunkirk Association**—This association is on nearly level to gently rolling areas of calcareous lake-laid silts in western New York. These areas are dominated by soils with medium textures and moderately restricted internal drainage. On gently sloping or undulating areas, the moderately well-drained Collamer soils occupy from 30 to 60 percent of the association. The somewhat poorly drained associate, which is unnamed, occupies from 10 to 30 percent of the association. On undulating and rolling areas are the well-drained Dunkirk soils. They occupy from 10 to 30 percent of the association. Poorly drained Canandaigua soils, on the level areas and in slight depressions where water accumulates, occupy from 5 to 20 percent of the association. Very poorly drained Colwood is a minor constituent. Throughout most of these areas, there are important inclusions of soils of other catenas, including the sandy Arkport and Junius, the clayey Fulton, and the medium-textured Hilton or Sodus soils. In most areas, these soils from sands, clays, and glacial till are very intimately intermingled with the dominant soils from silts.

The dominant soils are at least moderately productive of most vegetable crops, small grains, corn, and hay. Deep-rooted crops, such as tree fruits and alfalfa, are highly productive on the well-drained Dunkirk soils, but are moderately to severely limited on the less well-drained Collamer and Canandaigua. The outstanding management

problem is fertility maintenance. Most areas have acid surface soils and need lime, although lime is in the substratum. Phosphorus is generally deficient, and organic matter and nitrogen have been reduced seriously where cropping has been intensive. Potash may not give response under low intensities of cropping but must be supplied for really high yields. Special precautions are needed to control erosion on these highly erodible silty soils, even on gentle slopes. Many of the fields could be improved by artificial drainage of the lowest-lying wettest areas.

CG **Covington–Grenville Association**—This association occupies low ridges of highly calcareous glacial till protruding above poorly drained flats of marine clay. The well-drained, medium-textured, high-lime stony Grenville soils are on the ridges; the poorly drained, very heavy Covington soils dominate the flats. Covington soils occupy from 30 to 60 percent of the association; Grenville or its moderately well-drained associate, Hogansburg, from 20 to 50 percent. Poorly drained soils on calcareous glacial till, very poorly drained soils from clays, and moderately well- to poorly drained soils from sands appear as erratic inclusions.

The dominant Covington soils are used mainly for hay or pasture where drainage ditches are far apart, but may be used for corn and small grains also where systematic drainage has been installed. They need little lime or potash but are deficient in phosphorus. Poor drainage is the principal problem. Corn, small grains, and hay, including alfalfa, may be grown on the associated Grenville soils if they are not too stony. About one-half of the Grenville soil is, however, too stony for cultivation, and is used mainly for pasture. The Grenville soils need little lime but require phosphorus and potash for good yields. There is much yellowing of crops, indicating nitrogen deficiency, on the Covington soils because of wetness and slow release of nitrogen in the spring. Most farms have both kinds of these highly contrasting soils, and land use must be adjusted to their capabilities within farms.

CH **Clarkson–Hulberton Association**—Soils of this association are on undulating areas of glacial till from sandstone and limestone. They are mainly moderately well- to somewhat poorly drained soils with a slowly permeable pan below 15 or 20 inches. On the parts with distinctly undulating topography are the moderately well- to well-drained Clarkson soils. They occupy from 50 to 80 percent of the association and dominate the agriculture. On the nearly level areas, somewhat poorly drained Hulberton soils are found.

They occupy from 5 to 20 percent. The moderately well-drained, high-lime Hilton soils in glacial till, the moderately well-drained Collamer soils in lake-laid silts, or the somewhat poorly drained Fulton soils in lake-laid clays are important inclusions locally. The dominant soils have about 18 inches of material of good physical condition for rooting and good water-holding capacity but are rather low in fertility. Below that depth is a pan into which few roots penetrate.

Corn, small grain, hay, and most vegetable crops grow successfully on the dominant soils. Alfalfa is grown on the best drained sites. Tree fruits are grown with moderate success, but the older orchards commonly have lost trees on the lowest-lying areas. Yields where the trees persist do not equal those of orchards on soils that permit deeper rooting. These areas are potentially productive, but require intensive fertilization and careful choice of crops. For good yields, both phosphorus and potash must be supplied. Liming is essential for legumes, although there is lime in the substratum below the pan. Although drainage is moderately restricted, it is an outstanding problem only on the flat areas or in slight depressions. There is some evidence of erosion on the most intensively cropped places, but it is not an outstanding problem for the area as a whole. Supplemental irrigation is used by a few farmers for intensive vegetable production.

CHW **Charlton–Hollis–Woodbridge Association**—This association is on hilly areas of the New England uplands where glacial till, dominantly from schist, mantles the hillsides. The well-drained, very strongly acid, deep Charlton soils on the moderately to strongly sloping, convex parts of the valley sides occupy from 30 to 50 percent of the area, and only about one-third is gently sloping. The moderately well-drained, deep Woodbridge soils on the less strongly sloping areas where runoff is not so great occupy from 15 to 35 percent, of which about one-half is gently sloping. Both Charlton and Woodbridge have pan-like horizons below a moderately thick rooting zone with good water-holding capacity. On the steep hillsides or on complexly rolling but less steep portions of the valley sides, the shallow, drouthy Hollis soils occupy from 15 to 40 percent of the association and dominate some areas. Dutchess, Bernardston, and Nassau soils from slates may appear as local inclusions. About one-half of the area is too shallow or too steep for cultivation; only about one-fourth is easily cultivated.

The cultivable soils are commonly concentrated in areas large enough to support farm units, and the associated shallow or strongly sloping soils of such areas are used for pasture. The larger areas of

shallow or steep soils far from cultivable soils are forested or idle. Corn, small grains, and hay, including alfalfa, are the important crops. Sod crops are dominant in most areas. Lime, phosphorus, and potash may be needed for good yields, but the good physical condition of the upper part of the soil permits good response to their application. Erosion may be serious in some places, especially in areas that are not adequately fertilized, but it is not conspicuous for the area as a whole. Erosion can be a serious problem if intertilled crops are used frequently. You will see evidence of drainage problems in small areas, but it is not an outstanding problem for the area as a whole.

CM **Camroden–Marcy Association**—This association is on the broad, smoothly sloping hills of the Mohawk and Black River Valleys where the bedrock is dark-colored shale low in lime. The long, uniform slopes rise several hundred feet from the valley to the hill crest in these places. These slopes are covered with glacial till high in the dark-colored shales of the locality. The soil has inherited the dark color of the shale and has a strongly acid, medium-textured upper part over a more clayey, slightly acid to neutral fragipan below 15 or 20 inches. The dominant moderately well- to somewhat poorly drained Camroden soils on slightly convex, gently sloping to sloping topography occupy from 45 to 75 percent of the association. The poorly drained nearly neutral Marcy soils are on the flats and concave slopes where seepage water carrying lime is concentrated. They occupy from 5 to 20 percent of the association. On the distinctly convex strongly sloping areas, is the moderately well- to well-drained deep Pinckney or the shallow acid Manlius, which occupies from 5 to 30 percent. Locally very poorly drained Alden soils of the Poland catena, or the strongly acid poorly drained Gage, are important inclusions.

Crops tolerant of a cool climate and restricted soil drainage are best suited to this association. Corn for silage, oats, and hay account for almost all of the present cropped acreage. Yields of all crops are low unless the soils are limed and fertilized liberally; yields of adapted crops may, however, be moderate to good under an adequate liming and fertilization program. Lime and phosphorus are uniformly deficient. Potash release is too slow to support high crop production. Nitrogen must be supplied by good stands of legumes or by fertilization. Improvement of drainage is difficult because of the fragipan. Erosion can be serious on distinctly sloping areas if intertilled crops are grown frequently, or on very strongly sloping areas where the fertility level

is so low that cover is poor; but for the association as a whole, only small areas are seriously affected.

Co **Colonie and Otisville Associations**—These associations are on the very coarse-textured deposits of gravel and sand in the Hudson Valley. The Colonie Association is on sand of glacial-lake deltas, and the Otisville is on gravel of glacial outwash terraces. Both occupy nearly level to undulating topography. The drouthy, extremely acid Colonie soils in sands occupy from 70 to 90 percent of most areas, but in places they are replaced by the even more drouthy Otisville soils in gravel. Hoosic soils from shaly gravel, Claverack soils in sands over clay, Madalin soils in clay and soils from recent alluvium may appear as minor inclusions that may be important on some farms. Some areas of nearly neutral sands are also found in the northern part of the Hudson Valley. In the Shawangunk Valley, Otisville soils on terraces are associated with Basher soils of the first bottoms.

Low water-holding capacity limits agricultural use of most areas. Deep-rooted crops grow successfully in some areas, and general farm crops are produced in areas where there is a water table within the reach of plant roots. Deep in the subsoil of the Colonie soils are thin bands high in clay, and moisture relationships are better than normal where these bands are most strongly expressed. These soils are very low in lime, potash, phosphorus, and nitrogen, and response to fertilization is poor unless supplemental irrigation can be provided.

CO **Cazenovia–Ovid Association**—This association of productive, moderately fine-textured, well- to moderately well-drained soils is found where the glacier over-rode areas of red clayey shale or areas of reddish lake-laid clays and mixed them with limestone materials. On the distinctly convex slopes where drainage is best, are the well-drained, productive Cazenovia soils which occupy from 50 to 80 percent of the association. The somewhat poorly to moderately well-drained Ovid is found on the gently sloping areas where more water accumulates and occupies from 10 to 30 percent of the association. The poorly drained Romulus appears as a minor constituent on flat areas. On some farms, Honeoye, Cayuga, Wampsville, and Lockport soils may be important local inclusions. As much as 75 percent or more of the total area is on slopes that are easy to work. Stones, although present do not interfere seriously with cultivation.

While the choice of crops is somewhat restricted by the moderately

fine textures, these areas are highly productive of such crops as corn, small grains, hay including alfalfa, and some vegetable crops. The Ovid soils have drainage limitations that affect deep-rooted crops such as alfalfa. The dominant soils are among the more fertile soils of the State. The need for lime varies from farm to farm, although there is free lime in the substratum. The dominant soils have medium acid to neutral surface soils. Potash is generally well supplied by clays in the moderately fine-textured subsoil, but phosphorus is uniformly deficient. Maintenance of organic matter is important to maintain good soil structure. Erosion control deserves special attention on sloping fields. In small areas poor drainage is important, but it is not an outstanding problem for the area as a whole.

Cs **Catskill and Wurtsboro Associations**—These areas of steep hills and low mountains are almost entirely non-agricultural. Most of the area in the Catskill Mountains is in the Catskill association. Very stony Liberty soils formed from deep glacial till are dominant on the valley footslopes. The associated steep hillsides are dominated by the shallow or very shallow, extremely stony Catskill soils. On Shawangunk Mountain and on the southernmost edge of the Catskills is the Wurtsboro association. The moderately well-drained Wurtsboro soils are dominant on the less strongly sloping topography, but shallow soils and rock outcrops are on the steeper areas. In both associations, the dominant soils are extremely acid and low in the three major plant nutrients. In addition they are extremely stony, and topography is unfavorable for agriculture. Forestry, recreation, and water supply for urban areas are the principal uses for the soils of both associations.

CT **Chenango–Tioga and Howard–Chagrin Associations**—These two associations occupy the valley floors of the Allegheny Plateau and are the best agricultural land of the region. In the southern parts of these valleys, the very strongly acid well-drained Chenango soils are found on the nearly level glacial outwash terraces and occupy from 50 to 75 percent of the association. On the first bottomlands adjacent to the terraces is the well-drained, strongly acid Tioga or its moderately well-drained associate, Middlebury. These soils occupy from 10 to 30 percent of the area. In the northern parts of these valleys where limestone material is more abundant, the Howard soils replace Chenango on the glacial outwash terraces and Chagrin and Lobdell replace Tioga and Middlebury on the first bottomlands. In these northernmost areas, the soils are strongly or very strongly acid in the

upper part but have neutral material below depths ranging from 2 to 3 feet. In both associations, wet soils of terraces and bottomlands appear as minor constituents that may be important locally. In the valleys north of Munnsville and Deansboro on the northern edge of the Allegheny Plateau, the soils of the terraces are red because of the red shale in the parent material. These areas of Wampsville soils have been included because of small acreage.

The dominant soils have at least moderately good water-holding capacity and are well drained. Consequently, they are well suited to almost all crops commonly grown in the region and are very responsive to good management. They need lime, phosphorus, and usually potash, as well as practices to maintain nitrogen and organic matter. There is little evidence of erosion. These productive soils provide the nucleus of a good farm business for many farms that extend from the valleys into the adjacent uplands.

Cv **Coveytown–Cook Association**—This association is adjacent to the gravel and sand deposits of ancient beaches. The upper part of the soil is very sandy and extremely stony. The waves of ancient glacial lakes reworked glacial till material near the shore, washed away the fine material, and left the sands and stones behind. This very sandy, stony material overlies calcareous glacial till like that under the Parishville soils. Almost the entire area is poorly or very poorly drained and nearly level. The poorly drained Coveytown soils, on the uniform gentle slopes, occupy from 40 to 70 percent of the association. In the distinct depressions and on the flats are the very poorly drained Cook soils. Locally the very sandy, well-drained Adams on sand ridges, the somewhat poorly drained Saugatuck on sandy flats, or the heavy, poorly drained Madalin soils may appear as important inclusions. Except for local inclusions of better soils, these areas are principally non-cropland. They are commonly pastured on farms that have better soil for cropland.

DM **Dutchess–Macomber**[4] **Association**—These rolling to hilly areas of glacial till are in the "slate belt" on the edge of the New England upland region, and are characterized by well- to moderately well-drained, very strongly acid soils with fragipans on deep till in intimate association with extensive areas of shallow soil. On the convex, moderately to strongly sloping areas, the well-drained Dutchess and its moderately well-drained associate, Bernardston, are found. They occupy from 30 to 70 percent of the association.

[4] The Macomber soils were formerly included in the Nassau series in most areas.

The shallow or very shallow Macomber soils on the steep hillsides or on the complexly rolling topography in the valleys occupy from 20 to 50 percent of the association. On the flats in the valleys, the somewhat poorly drained Stissing, the poorly drained Mansfield, or the well-drained gravelly Hoosic soils may appear as important inclusions. In some places, the deep soils are in large areas adequate for one or more farm units and the shallow soils are concentrated in equally large areas of non-cultivable soils. In other places, the deep and shallow soils are so intimately intermingled that fields must be small and irregular in shape. Loose stones limit cultivation of the deep soils in some areas.

The dominant deep soils are suited to corn, small grains, hay, and a number of vegetable crops, but require intensive fertilization and liming for good yields. The soils are very strongly acid and are deficient in both phosphorus and potash. Where they are farmed under low fertility levels, legumes are not persistent and nitrogen deficiency is strikingly evident by the yellowing of the crops. Drainage is a minor problem on most farms. There is much evidence of erosion where intertilled crops have been used frequently. Pastures are poor on the shallow, drouthy Macomber soils. Where the deep soils are in units large enough to support a farm business, this association is potentially good farm land. Where the shallow soils dominate, the areas are non-agricultural.

DR **Darien–Romulus Association**—Soils of this association are in undulating areas of moderately fine-textured glacial till derived mainly from weakly calcareous clayey shale. The moderately fine-texture and the dominantly restricted drainage are outstanding characteristics of the soils. The moderately well- to somewhat poorly drained Darien soils dominate the slightly undulating to gently sloping parts and occupy from 35 to 60 percent of the association. On the nearly level places, is their poorly drained associate, Romulus. It normally occupies from 20 to 40 percent. In a few places in western New York, the somewhat poorly drained Fulton or poorly drained Madalin soils, from lacustrine silty clays, partly replace Romulus in the association. Locally, the well-drained Lansing, the moderately well-drained Conesus, or the very poorly drained Fonda soils may be important inclusions. The slopes of few areas exceed 8 percent in gradient.

These areas of moderately fine-textured soils are used principally for crops grown in support of dairying. Wheat is among the most productive of the small grains, and alfalfa is productive only on the best drained sites. There is some sweet corn and tomato production, but

most crops other than hay are restricted to the Darien component unless some degree of artificial drainage has been established. Darien needs lime consistently, but some areas of Romulus may not need lime. Phosphorus is required on all areas, but potash is needed only for special crops. There are signs of erosion in most areas, for the dominant soils are exceptionally erodible even on gentle slopes. The need for drainage is an outstanding problem, however, on most farms. These soils do not respond so well to fertilization as do soils with better physical condition in adjacent areas, but this association can be moderately productive of adapted crops under good management.

EL **Erie–Langford Association** – This association occupies broad, smoothly sloping, till-mantled hills along the northern edge of the Allegheny Plateau. The long uniform slopes from valley floor to hill crest range from less than ½ mile to several miles in length. Water accumulates above a slowly permeable fragipan horizon in the dominant soils on these long slopes and makes the most important soils somewhat poorly drained. The somewhat poorly drained Erie soils, found on the long uniform slopes, occupy from 45 to 70 percent of the association. On knolls and on the uppermost convex parts of the hills are the moderately well-drained Langford soils. They occupy from 15 to 30 percent of the association. The poorly drained Ellery is on the flats and on the small wet spots on the slopes and makes up from 5 to 10 percent of the association. The deep, well-drained Valois, the shallow, well-drained Lordstown, or the shallow, somewhat poorly drained Angola may be important inclusions on some farms.

Crops that require early planting are at a disadvantage. For example, winter wheat commonly out-yields spring-planted grains in terms of feeding value. Corn, small grains, and hay, exclusive of alfalfa, are the principal crops grown. Yields of the adapted crops are moderate to good if the soils are limed and fertilized liberally and if other management requirements are met. Lime and phosphorus are uniformly deficient and the potash supply is adequate only for mediocre yields. Within the area there is much yellowing of crops, suggesting nitrogen deficiency, which is common as a result of lack of persistent legumes in hay crops. Although drainage is one of the most important problems, the soils are difficult to drain because of the presence of the fragipan. This is most acute where small spots of Ellery soil within fields control the timeliness of work. There is some evidence of erosion, for the amount of water that is concentrated on the long slopes may be very great.

ES **Elmwood–Swanton Association**—The nearly level areas of this association are moderately well- to poorly drained sands. The soils are either deep sands with a regionally high water table or wet sands shallow or moderately deep over clay. On the nearly level to gently sloping areas, which occupy from 20 to 50 percent of the association, is the moderately well- to somewhat poorly drained Elmwood soil in sand over clay or its equivalent in deep sands. In distinct depressions or on the very large level areas is the poorly drained Swanton in sand over clay or its equivalent in deep sand. These poorly drained soils occupy from 20 to 55 percent of the association. The very poorly drained, as well as the well-drained sands, are minor constituents. Typically the soils are slightly to strongly acid, but there are some nearly neutral areas.

About one-half of most areas has limited agricultural use unless artificial drainage has been established. This is the half occupied by Swanton soils. Most of the remainder is adapted to cropping and is very productive of vegetables and general farm crops if adequately limed and fertilized. These are the Elmwood areas. Crops such as alfalfa and the tree fruits that are especially sensitive to wet subsoil conditions are poorly suited to most areas in this association. The soils are low in fertility, especially in phosphorus and potash, but respond well to lime and complete fertilizer if they are adequately drained.

EW **Empeyville–Westbury Association**—The soils of this association are on undulating to rolling areas of glacial till, predominantly from sandstone, in the St. Lawrence Valley and Tug Hill areas. The dominant soils are moderately coarse and have fragipans below 15 to 24 inches. The moderately well-drained Empeyville, on distinctly undulating or rolling areas, accounts for 40 to 75 percent of the association. The somewhat poorly drained Westbury, on uniform gentle slopes, occupies from 10 to 25 percent. Small areas of well-drained Worth, poorly drained Dannemora, and very poorly drained Tug Hill appear as minor constituents on most farms. Colosse or Colton soils in gravel are included locally. All of the area is stony and about one-fourth is too stony for cultivation.

This association is in areas of cool climate where corn for silage, oats, and hay are the principal crops. Crops such as potatoes are grown on some areas, but stoniness limits intensive use of most areas. Low fertility is an outstanding problem. Lime, phosphorus, and potash must be supplied liberally for good yields, and lack of a persistent legume in the hay fields makes nitrogen a common limiting nutrient. This lack of legumes is closely associated with inadequate liming and fertilization. Under prevailing use, erosion is evident in few places.

F **Farmington and Nellis Associations**—The areas of these associations are dominated by soils shallow to limestone bedrock. In areas south of the Mohawk Valley and in western New York, the shallow medium-textured acid Farmington soils dominate. In the Mohawk, Black River, and St. Lawrence valleys, these areas are dominated by shallow phases of the nearly neutral Nellis soils. Farmington or Nellis occupies from 60 to 90 percent of each area and is mainly on nearly level to gently undulating topography. As much as 50 percent has less than 12 inches of soil over rock. Such soils are unsuited to cultivation and are productive of pasture only in the spring. Locally the soils are deep enough for cultivation, and in these places they may be moderately productive. The dominant soils are better supplied with plant nutrients than most areas of the State. Lime is needed on the Farmington soils but not on Nellis. Potash is normally slightly deficient on Nellis, but not on Farmington. Phosphorus is uniformly deficient. Where these shallow soils are in large areas, they are mainly idle, but where deeper soils are associated with them, they are used for pasture or may be cropped.

FT **Fulton–Toledo Association**—Wetness and fine texture severely limit the use of these nearly level areas of lake-laid clays and silts. On the areas with visible slope, the somewhat poorly drained, fine-textured Fulton soils dominate. They occupy from 30 to 70 percent of the association. Poorly drained Madalin soils on the level areas account for 20 to 40 percent of the association. In the distinct depressions or in the middle of large flats is the very poorly drained Toledo. It occupies from 10 to 30 percent of the association. Commonly the areas of each of the major constituents are large, and some fields may be entirely on only one of the three. Moderately well-drained clays, wet sands, and somewhat poorly drained soils on till are important inclusions locally.

The Fulton soils are commonly used for corn, oats, wheat, and hay, but the Madalin soils are used for little except hay and pasture mixtures tolerant of wet conditions where they are not artificially drained. Effective surface drainage makes Madalin suitable for the normal rotations of dairy farms. The Toledo soils are too wet for cultivation and are difficult to drain. The dominant soils are better supplied with plant nutrients than most areas of the State. They are neutral or only medium acid, and potash is generally high. Phosphorus is uniformly deficient. Drainage is the outstanding problem, but maintenance of good tilth is important in cultivated areas. There is little evidence of erosion on these nearly level areas.

G **Gloucester–Essex–Rockland Association**—This association comprises undulating to hilly areas of glacial till from granitic rock on the borders of the Adirondack highlands. The well-drained Gloucester soils, which have a weak or no pan horizon, are associated with Essex soils, which have a strongly expressed pan. These two well-drained soils are on the distinctly undulating or rolling topography and occupy from 30 to 60 percent of the area. On the uniform slopes and in slight depressions, the moderately well- and somewhat poorly drained associates of Essex are found. They occupy from 20 to 40 percent of the area. The drouthy, gravelly Hinckley soils, the drouthy, sandy Windsor, and rockland are important inclusions. The area is all stony and about two-thirds is too stony for cultivation.

Some local areas that are not too stony are cultivated for crops such as corn, oats, hay, and some vegetables. A few areas support moderately good farms. Most of the area is, however, marginal or submarginal for agriculture. The soils are very strongly acid and are low in all the major nutrients. Most of the area is forested or idle.

GE **Genesee–Eel Association**—This association occupies nearly level first bottomland subject to spring floods. The well-drained Genesee soils, nearest the rivers, occupies from 20 to 50 percent of the area. At some distance from the stream channel, the soils are only moderately well-drained and Eel soils predominate. They occupy from 30 to 50 percent of the association. The poorly drained Wayland adjacent to the uplands occupies from 5 to 15 percent of the area. Palmyra or Honeoye soils may be important inclusions on some farms.

Most of the areas are intensively used and highly productive of a wide variety of crops, including vegetables as well as the crops of general farms. Floods cause damage occasionally, but floods are usually confined to the early spring before planting. Soils of the Genesee-Eel association are among the most fertile and valuable agricultural land in the State, but phosphorus is needed for highest production of all crops and a complete fertilizer is generally needed for good production of the intensive vegetable crops. The dominant soils have good water-holding capacity and respond well to good management practices.

H **Hoosic Association**—The Hoosic association in the Hudson Valley is on nearly level to gently rolling areas of glacial outwash gravel and sand. The material came mainly from slate and shale. On most of the level terraces, as well as on the undulating to rolling hills, the well-drained very strongly acid Hoosic soils are found. They occupy from 60 to 80 percent of most areas. In distinct depressions and along streams are the less well-drained members of the Hoosic catena, or soils of the first bottomlands. Locally the gravel is dominated by sandstone or granitic rocks, and in these areas the very drouthy, coarse textured Otisville soils dominate.

The dominant soils are potentially productive of most crops grown in the Hudson Valley, but are deficient in lime, potash, phosphorus, and nitrogen. On farms with a poor fertility and liming program, production is inferior. On farms with good management programs, response to lime and fertilizer is good. Most areas have only moderate water-supplying power, and yields would be increased by supplemental irrigation in dry years. Drainage and erosion control are minor problems.

HB **Hempstead–Bridgehampton Association**—This nearly level to gently sloping area on Long Island is unique because it is the only area of the State on which the dominant soils appear to have developed under grass. It has a deep dark-colored surface soil, like that of the Prairie soils of the Corn Belt. The dark-colored, well-drained Prairie soil, Hempstead, occupies about 75 percent of the area. Bridgehampton soils are the principal associates. Both the Hempstead and Bridgehampton are very strongly acid and are low in phosphorus and potash.

The dominant soils have good water-holding capacity and, although low in lime, phosphorus, and potash, give good yields when adequately fertilized. Where supplemental irrigation is practiced, even higher response to good management is commonly obtained. Mainly potatoes and vegetables are grown in the cultivated areas, but the areas are adapted to a large number of crops. Their location near New York City has largely controlled their use, and most of the area has been incorporated in urban development.

HBR **Hermon–Becket–Rockland Association**—This soil association represents the major part of the Adirondack highlands. The dominant soils are strong Podzols, with striking gray-leached horizons over a reddish yellow, iron-rich subsoil. The dominant soils are from sandy glacial till consisting mainly of granitic rock

material. The well-drained Hermon soils with weak or no pan, and the well-drained Becket soils with strongly expressed pans, dominate in association with their less well-drained catena members. In the valleys, the very coarse gravelly Colton soils are prominent. In the valleys of the eastern part of the area, the glacial till is dominated by Grenville gneisses and schists, with some limestone as a minor constituent. In these areas are the Weak Podzols comparable to Gloucester. Locally the crystalline limestone has given Brown Forest soils, such as Dover on glacial till and Bonaparte on glacial outwash. No attempt has been made to differentiate on the map these distinctive conditions. All of the areas are very stony or very drouthy and essentially non-agricultural. Some agriculture is practiced locally in the valleys, and the soil problems of these areas are centered mainly on drouthiness and extremely low fertility.

Hh **Howard, Hoosic, Chenango, and Arkport Associations, Hilly Areas**—The topography in these areas is complex rolling to hilly. These areas of gravel and sand are places where the ice front stood and melted for long periods, leaving hilly deposits of water-sorted material. Weathering has made the upper part of the soil fine enough to provide fair water-holding capacity although the substratum is very coarse. The soils listed occupy from 65 to 80 percent of their respective areas. Wet alluvium, poorly drained soils from gravel, and local areas of soils from glacial till are important inclusions in some places.

Topography, moderate drouthiness, and moderately low fertility limit the agriculture on these soils. In most areas, from 10 to 40 percent is unsuited to cultivation because of steep slope. Some farms have enough good cropland on moderate slope to support very good dairy-farm units. Many farms have more limited amounts of good cropland but a high proportion of soil at least moderately well suited to hay and pasture. The soils are deficient of lime, phosphorus, and potash, and give moderate response to treatment within the limits of their capacity to supply water.

HK **Hilton Association**—This association comprises undulating areas dominated by moderately well-drained soils from calcareous glacial till. The moderately well-drained Hilton soils on gently undulating or gently sloping topography occupy from 50 to 75 percent of the area. An unnamed somewhat poorly drained soil from similar material is in distinct depressions or on flats, and occupies from 5 to 25 percent of the association. In some areas, the

moderately well-drained Collamer, developed from lacustrine silts, appears as a major inclusion that may occupy as much as 35 percent of some farms. The Ontario, Colwood, and Lakemont soils appear as minor inclusions. The dominant soils have good water-holding capacity and are at least moderately responsive to fertilization.

Corn, small grains, hay, and most vegetable crops are at least moderately well suited to these areas. Deep-rooted crops, such as alfalfa and tree fruits, do best on the distinctly convex slopes of the moderately well-drained Hilton soils. Lime is commonly but not everywhere required for legumes, and phosphorus is uniformly deficient. Potash may become deficient under intensive cropping. Organic matter has been seriously decreased in the most intensively cropped areas, and there are some signs of erosion on the more strongly sloping parts. Most of the area would be improved to some degree by artificial drainage, and some small areas need drainage badly. The dominant soils, potentially at least, are moderately productive of most crops without artificial drainage.

HL **Honeoye–Lima Association**—The deep, high-lime soils of the Honeoye-Lima association are from glacial till and are commonly used as the standard for comparison of productivity of general farm crops in western New York. The areas are undulating to gently rolling in western New York, but more strongly rolling south of the Mohawk Valley. On the distinctly convex slopes, ranging from undulating to hilly, where water does not accumulate, are the well-drained high-lime Honeoye soils. They occupy from 30 to 60 percent of the association. The moderately well-drained Lima soils on less distinctly convex areas but still with good surface drainage occupy from 30 to 70 percent of the association. Lima is dominant on many areas. On flats where water accumulates, the somewhat poorly drained Kendaia soils account for from 5 to 20 percent of the association. The very poorly drained Lyons is normally present in minor amounts. The gravelly Palmyra and the more acid Lansing soils or members of their catenas appears as local inclusions.

In western New York, some of the most prosperous agriculture of the State is on these areas. South of the Mohawk Valley elevations are higher, growing seasons are shorter, and topography is less favorable. The agriculture appears prosperous only locally in this region, although the soil profiles are very much like those of western New York. To what extent topography and growing season are the cause is not known. The dominant soils of both regions are well suited to all crops climatically adapted to the region. In most places these soils

need no lime, but some areas need a moderate amount of lime for legumes. Phosphorus is uniformly deficient, but potash is needed only where cropping is very intensive. Organic matter was originally high, but intensive cropping has seriously reduced it in some areas of western New York. There is some evidence of erosion, especially in the more intensively cropped areas of western New York. Drainage is critical on small wet areas, but the wet soils are generally drainable. In the drier areas of western New York, some supplemental irrigation is needed for high-value cash crops as insurance against periodic dry weather.

IT **Ilion–Turin Association**—This association is on nearly level to undulating topography. The parent material is glacial till from dark-colored calcareous shale, with variable proportions of sandstone or granitic material. The soils are moderately fine to medium textured and dominantly have restricted internal drainage. On the nearly level parts, the poorly drained, dark-surfaced, nearly neutral Ilion soils are found. They occupy from 30 to 60 percent of the association and dominate the land use of most areas. On the distinctly sloping parts, the moderately well- to somewhat poorly drained Turin soils dominate. They occupy from 20 to 50 percent of the association and on some farms provide enough good cropland to support efficient farm units. Well-drained Poland or Mohawk, very poorly drained Fonda, moderately well-drained Mosherville, and somewhat poorly drained Fulton soils appear as minor inclusions locally. Few slopes exceed 8 percent in gradient, and much of the area is so nearly level that runoff is slow.

Poor drainage is the outstanding problem. The Ilion soils, which occupy about one-half of most areas, are suitable mainly for hay or pasture in their undrained condition. If adequately drained, they are productive of the crops commonly grown in support of dairying. The better drained Turin soils can be used successfully for most crops adapted to the climate. The soils are above average in fertility. Ilion soils need no lime, whereas Turin has a moderate lime requirement, although the substratum is calcareous. Potash is rarely deficient, but phosphorus is needed consistently. There is little evidence of erosion on these nearly level areas.

JG **Junius–Granby Association**—This association appears where sands were deposited near the margins of the ancient glacial lakes that occupied portions of the Erie-Ontario plain. The areas are dominated by nearly level, neutral, somewhat poorly to very poorly drained soils in medium and fine sands. On the

nearly level areas, the somewhat poorly drained Junius soils occupy about 50 percent of the association. The poorly to very poorly drained Granby soils, in the slightly depressed or very flat areas, account for about 20 percent of the association. The remaining area consists of varying proportions of moderately well- to well-drained soils in sands or silts with minor inclusions of wet soils, such as Kendaia or Lyons, from glacial till.

Where undrained, these areas are used mainly for hay, pasture, or forest. Artificially drained, they make excellent cropland for most vegetables and for general farm crops. Most areas are adequately supplied with lime, but the best drained parts may need lime for legumes. All areas need potash and phosphorus. Although the dominant soils are high in organic matter, there is a response from nitrogen fertilization in the spring when release of nitrogen is slow.

L **Lockport Association**—These nearly level or gently sloping areas are dominated by somewhat poorly to moderately well-drained, reddish colored, clayey soils that are shallow or only moderately deep over reddish colored shale. On the gently sloping or gently undulating parts, the clayey, moderately well- to somewhat poorly drained Lockport soil dominates. It occupies from 50 to 80 percent of the association. About one-half of the Lockport soil is less than 20 inches thick over shale. Locally its grayish colored equivalent, Cicero, replaces or is in intimate association with the dominant Lockport soils. In depressions or on flats, the clayey, poorly drained Romulus soil dominates and may occupy as much as 15 percent of some areas. Locally, Cazenovia, Ovid, Camillus, or Honeoye soils may appear as important inclusions.

These heavy, shallow soils have poor structure and low water-supplying ability. Although the deeper areas support dairy enterprises with grasses prominent in the cropping system, much of the association is idle or is used for pasture in conjunction with better cropland of other associations. The lime requirement is variable from place to place, ranging from none to high, although the shale bedrock is neutral or calcareous. Phosphorus is consistently deficient, but potash is rarely deficient.

LC **Lansing–Conesus Association**—This association is in the transitional belt between the high-lime Honeoye soils on the north and the low-lime Langford and Erie soils on the south. It is on undulating to rolling areas, and is dominated by well- and moderately well-drained soils from calcareous glacial till derived largely from shale with varying amounts of limestone. The well-

drained, medium-textured Lansing soils, which occupy from 40 to 75 percent of these areas, are on gently to strongly sloping convex topography where water does not accumulate. The associated moderately well-drained Conesus soils are on gently sloping topography and occupy from 15 to 35 percent of the association. On the flats, is the somewhat poorly drained, medium-textured Kendaia. The somewhat poorly drained, moderately fine-textured Darien soils may be present locally where the shales are unusually clayey.

Most crops climatically adapted to the area are well suited to the dominant soils. These include corn, small grains, hay, dry beans, and vegetable crops. Although there is lime in the substratum, the surface soils are strongly acid and liming is one of the most important management requirements. Phosphorus is uniformly deficient, and potash becomes deficient under intensive cropping. There is some evidence of erosion on the sloping areas. Artificial drainage is needed mainly on small areas. The soils respond well to good management, but crops are poor where the fertility and liming program is inadequate.

LE **Langford–Erie Association**—These areas of low-lime glacial till have soils with slowly permeable fragipans below 15 or 20 inches, but the distinctly undulating or rolling topography helps to remove water and results in dominantly moderately good drainage. On the undulating to gently rolling distinctly convex slopes, the moderately well-drained medium-textured acid Langford soils occupy from 25 to 50 percent of the area. The well-drained Valois, on the more strongly sloping parts, occupies from 10 to 30 percent of the association. On gently sloping uniform topography where seepage and runoff are concentrated, the somewhat poorly drained acid Erie soils are found. They occupy from 10 to 30 percent of the association. All of these soils have pans that are neutral in the lower part, but the soil above the pan is strongly acid. In the gently sloping or nearly level areas where lime-bearing water accumulates are the neutral, poorly drained Ellery soils. Ellery appears mainly in small areas and occupies less than 10 percent of the association. Lordstown, Manlius, and Volusia soils are important inclusions locally. Almost all of the area has a distinct slope, but little is too steep for cultivation.

Although a high proportion of the area has moderately restricted internal drainage, natural drainage is good enough on about one-half of the area to permit growth of most crops climatically adapted. Corn, small grains, and hay, are those most commonly grown. Alfalfa is found on Langford and Valois soils that have been adequately limed and fertilized. Lime and phosphorus are consistently deficient, and

the use of potash becomes more important as yields are increased by other practices. On the Erie soils, which need drainage, the fragipan makes drainage costly, and most farmers use them for crops tolerant of somewhat wet conditions. There is some erosion, but under the prevailing systems of cropping, which employ a high proportion of sod crops, erosion is only a moderate problem. If intertilled crops are used frequently, erosion is commonly serious.

Ls **Lordstown Association**—The areas of this association are so dominated by steep shallow soils that little agriculture is practiced. The well-drained but steep, shallow Lordstown soils occupy from 30 to 65 percent of the association. On narrow, moderately sloping areas in the valleys, the somewhat poorly drained Volusia soils are found. They occupy from 10 to 30 percent of the association. On the hill crests or on the best drained parts of the moderately sloping areas in the valleys, the moderately well-drained Mardin soils occupy from 10 to 20 percent. Where the valleys are widest, the well-drained nearly level Chenango or Tioga soils may support a farm unit.

Most of the association is forested. There is some agriculture in the valleys where Volusia and Mardin soils on glacial till or Chenango on alluvial fans occupy large enough areas. Such local areas have problems and limitations like those of the cultivable land of the Lordstown-Volusia association described in the following paragraph.

LV **Lordstown–Volusia Association**—The areas of this association are typical of the hill-valley region of the southern tier of counties. The valley floor is normally an outwash valley train, and the largest of these have been separated on the soil map as the Chenango-Tioga association. Typically deep glacial till occupies a uniformly sloping area that extends for ⅛ to ½ mile from the valley floor. These sloping areas dominated by gently to strongly sloping, somewhat poorly drained Volusia soils occupy from 20 to 40 percent of the association. At the upper boundary of the Volusia slope is an abrupt slope break to steep, shallow Lordstown soils in most areas. This steep part of the association occupies from 20 to 40 percent of the area. On the hill crest above these steep slopes is the moderately well-drained, sloping Mardin or the well-drained sloping Bath soil. These two soils occupy from 10 to 25 percent of the total area. They are the best upland soils of the association, but they are commonly far from farmsteads and are difficult to reach. The well-drained Chenango soils on the narrow valley floors and the poorly drained Ellery, the very poorly drained Alden, or the very poorly drained Chippewa soils on

seepy areas of the valley foot slopes are important inclusions.

Where the valley floors are wide, cropland is concentrated on the Chenango-Tioga association and the adjacent Volusia soils are used for hay or pasture. Soils of the Chenango-Tioga association are excellent for most crops. Farms wholly within the Lordstown-Volusia association must depend mainly on Volusia and Mardin soils for cropland; and on these farms, corn for silage, small grains, and hay excluding alfalfa are the principal adapted crops. Liming and fertilization with phosphorus are essential for even moderate yields, and lack of persistent legumes makes nitrogen deficiency an important fertility problem on the upland soils. Drainage, too, is an outstanding problem on these soils and it is intensified by the presence of small seepy areas of Ellery or Chippewa soils. There is some evidence of erosion, especially where intertilled crops are used or where low fertility causes poor vegetative cover on strongly sloping soils. The cultivable areas have the same kinds of problems as the Volusia-Mardin association, but these areas are interspersed with large tracts of non-cultivable Lordstown soils, most of which are forested.

LW **Lackawanna–Wellsboro Association**—This association is on the high hills bordering the Catskill Mountains where red shale and sandstone are the dominant kinds of bedrock. Deep, glacial till fills the valley bottoms and mantles the lower slopes, but the hilltops and upper slopes typically have soils shallow over bedrock. The shallow Oquaga soils are on these upper slopes. Oquaga occupies from 15 to 30 percent of the area and is mainly forested. The deep, well-drained Lackawanna soils are on convex, moderately to strongly sloping areas, partly on the lower slopes and partly on the hilltops. Lackawanna occupies from 20 to 35 percent, about one-half of which is strongly sloping and stony. The moderately well-drained Wellsboro is found from the middle of the hillside to the valley floor on moderately sloping and slightly convex areas. Wellsboro covers from 20 to 35 percent of the total area. Somewhat poorly drained Morris soils that occupy from 10 to 20 percent of the association appear on the concave seepy parts of the hillsides. Very poorly drained Norwich is on the lower slopes, and narrow areas of the well-drained gravelly Tunkhannock or well-drained silty Basher soils are on the valley floors as minor constituents.

Agriculture is confined mainly to the deep-till areas of the lower slopes and valley heads where the Wellsboro soils dominate in association with Lackawanna and Morris. Here there is adequate deep soil on moderate slope to support dairy farming. Here corn for silage

and oats on a moderate acreage, with hay as the dominant crop, grow well. Locally, cauliflower is produced on the best drained soils. Maintenance of a high fertility level is an outstanding problem in the existing agriculture. The dominant soils are very strongly acid and are low in phosphorus. Although potash deficiency may not be apparent under the common intensity of cropping, it normally becomes deficient as crop yields are increased by other practices. Maintenance of legumes in the sod crops is poor on many areas, and thus nitrogen-deficiency symptoms are common in these areas. Although erosion is potentially a serious problem on such strong slopes, it is not currently serious for the area as a whole because of the high proportion of sod crops on the land. The land-use pattern of the association is distinctive; the lower slopes support a very important dairy industry, but the upper slopes and hill crests are mainly in forest.

Madrid–Bombay and Madrid–Collamer Associations—The Madrid-Bombay association is mainly in the Champlain Valley, and the Madrid-Collamer association is in the southern part of the St. Lawrence Valley. Both are areas of low drumlins or till ridges interspersed with nearly level areas. Glacial till is the dominant material on both the ridges and flats in the Madrid-Bombay areas. Glacial till occupies the ridges, but lake-laid silts are dominant on the flats in the Madrid-Collamer areas. In both associations, the well-drained productive high- to medium-lime Madrid soils are on the till ridges and occupy from 40 to 60 percent of both associations. The Madrid slopes are mainly gentle, but as much as one-third may be steep enough to cause some difficulty in cultivation. On the intervening, nearly level or undulating areas, are either the moderately well-drained Bombay soils in glacial till or the moderately well-drained Collamer in lacustrine silts. One of these two soils occupies from 25 to 45 percent of each area. The somewhat poorly drained Kendaia in glacial till or the poorly drained Canandaigua in lacustrine silts on the level or slightly depressed areas appears as a minor constituent. Locally, the high-lime Nellis soils replace Madrid. The very poorly drained Lyons, the moderately well-drained very heavy Vergennes, or the strongly acid silty Amboy are important inclusions on some farms.

Most crops that are adapted climatically to the region are well suited to the dominant soils. These crops include corn, small grains, hay, and most vegetables. Alfalfa and other drainage-sensitive crops do well on the Madrid soils but are not adapted to the somewhat poorly drained Bombay and Collamer soils. Although the substrata of

the soils of this association typically contain free lime, liming is necessary for legumes in almost all areas. Phosphorus and potash are consistently deficient. The dominant soils have good physical condition, however, and respond well to fertilization and liming. Under the prevailing agriculture there is not much evidence of erosion, although a shift of agriculture to more intertilled crops would create an important erosion hazard. Drainage is usually needed locally on the areas between the till ridges.

Mu **Muck**—These areas of organic soils are not differentiated as to kind, but the areas shown all contain a significant acreage of deep muck suitable for cultivation if adequately drained. When drained and cultivated, these areas are very productive of special crops and are highly valued. Many small areas of very productive muck could not be shown on the soil map. A high proportion of these are in the drumlin areas of the Ontario association and in the Sodus-Ira association.

N **Nassau, Macomber, and Manlius Associations**—These areas are dominated by shallow or very shallow soils and are mainly non-agricultural. The Manlius soils dominate in areas on sandstone and shale, Nassau on the slates of the Hudson Valley, and Macomber on similar rocks in areas bordering New England. One of these three shallow soils occupies from 50 to 70 percent of these areas. Bedrock outcrop typically occupies from 10 to 25 percent. The remainder is mainly moderately well-drained, deep soil from glacial till. In the various areas, topograph ranges from rolling to steep.

In a few places, areas of deep soil inclusions are large enough to support farm units. In most areas, however, the shallow soils are so dominant that the cropland available is poor at best. Many areas cannot be cultivated. Most of the areas are forested or idle or support a very poor agriculture. Response to fertilization and liming and to other good management practices is poor, because low water-holding capacity limits the yields on these soils. They are very strongly acid and low in phosphorus, potash, and nitrogen.

NA **Nellis–Amenia Association**—These nearly level to sloping areas are dominated by well- and moderately well-drained soils from highly calcareous glacial till, mainly from limestone. The dominant soils have exceptionally good structure, but a high proportion is shallow to bedrock. The well-drained Nellis soils are found on the areas with distinct slopes, especially if the slopes are

slightly convex. They occupy from 40 to 70 percent of the area, and from one-fifth to one-half is less than 24 inches deep over bedrock. The moderately well-drained Amenia soils are found on the nearly level areas or on slightly concave gentle slopes. They occupy from 20 to 30 percent of the association. Less than one-fourth of the Amenia is shallow to bedrock. Poorly drained Kendaia in depressions, and soils from glacial outwash, lacustrine silts, and shaly glacial till appear as local inclusions that may be important on some farms.

Dairy farming is prosperous where the acreage of Nellis and Amenia soils more than 24 inches deep is great enough to support farm units. These soils are very productive of a wide variety of crops under good management. Hay, oats, and corn are the principal crops grown, but most vegetable crops climatically adapted to the region are well suited to these soils. The shallow areas are drouthy and are commonly included in permanent pastures. In some places, there are relatively extensive shallow areas typically forested or idle. The dominant Nellis and Amenia soils are nearly neutral throughout, but some areas have strongly acid profiles over calcareous material at 30 or 40 inches. Both potash and phosphorus are typically deficient, but response to them is high. Drainage is needed only locally for wet spots in fields. Under existing agriculture, erosion is slight; but if these soils were used intensively for clean-cultivated crops, erosion control would be an important problem.

NP **Nellis–Panton Association**—These are areas in which highly contrasting soils are intimately associated. Low glacial-till ridges dominated by limestone material alternate with nearly level low-lying areas of marine clays. The well-drained high-lime Nellis soils are on the gently to moderately sloping till ridges. Nellis occupies from 30 to 60 percent of the area. The poorly drained, very heavy Panton or Covington soils are on the intervening flats, which occupy from 15 to 40 percent of the area. Small areas of poorly drained Kendaia on the till ridges and the very poorly drained Livingston on the clay flats appear as minor constituents. The sandy wet Swanton soils appear as local inclusions.

The crop adaptations and management needs of the soils on the ridges contrast greatly to those on the flats. The well-drained productive Nellis soils are adapted to all crops commonly grown in the region, while the intervening low-lying poorly drained Panton or Covington soils are suited principally to hay or pasture unless they are artificially drained. Potash is generally needed on the Nellis soils but not on the Panton or Covington, and phosphorus is needed on both

areas. Most of the areas need little or no lime, but local areas need lime for legumes. Erosion is important locally on the Nellis, whereas drainage is an outstanding problem on Panton and Covington. Commonly the proportion of Nellis to Panton or Covington permits adjustment of land use for efficient dairy farming.

NS **Nellis–Swanton Association**—In areas of this association, low ridges of calcareous glacial till from limestone are interspersed with low-lying flats of poorly drained sand over clay. The well-drained, high-lime Nellis soils are on the gentle to moderate slopes of the till ridges. Nellis occupies from 40 to 60 percent of the area. The poorly drained sandy Swanton soils are on the intervening flats and cover from 15 to 40 percent of the association. Poorly drained Kendaia on the till ridges and the very poorly drained, sandy Whately on the flats appear as minor constituents. Locally the heavy, poorly drained Panton or Covington soils on the flats appear as important inclusions.

Crop adaptations and management needs on the till ridges contrast greatly to those on the sandy flats. The dominant Nellis soils on the till ridges are productive of almost all crops adapted to the climate, whereas the sandy, poorly drained Swanton soils on the flats are limited mainly to hay or pasture in the undrained state. Where the Swanton soils have been drained artificially, however, they are adapted to most crops except those very sensitive to a wet subsoil. The Nellis soils need lime only locally; lime requirement on the Swanton soils ranges from moderate to low. The Nellis soils generally need some potash, but the Swanton soils are much more deficient. Both are low in phosphorus. Erosion control would be an important problem on the Nellis soils if intertilled crops were used frequently, whereas artificial drainage is an outstanding problem of the Swanton soils.

Od **Ontario Association, Drumlin Areas**—The topography of this association is striking. The association is dominated by elongated cigar-shaped hills called *drumlins,* which range from ¼ to 2 miles in length and from ⅛ to ¾ mile in width. These drumlins are deposits of calcareous glacial till from limestone and sandstone. On the convex, strongly to moderately sloping parts of these hills are the well-drained Ontario soils, which occupy from 50 to 70 percent of the area. Approximately one-half of this is on slopes steep enough to be difficult to cultivate. On the uniform, gently sloping lower parts of the hills and on the gently undulating areas be-

tween them are the moderately well-drained Hilton or Lima soils, which occupy from 20 to 30 percent of the association. In the flat areas, the poorly drained Kendaia and, in the shallow depressions, the very poorly drained Lyons soils between the drumlins appear as minor constituents. Locally between the drumlins, soils from glacial outwash or from lake clay are important inclusions.

Topography limits the agricultural use of the soils on many farms in this association. Soils on moderate slopes are well suited to corn, oats, hay, most vegetable crops, and fruits that are climatically adapted to the area. Some farms are dominated by such moderately sloping soil. In many sections, however, areas of gently sloping soils are small and are interspersed with strongly sloping drumlin sides that make tillage difficult. Erosion is severe on many of the steeper areas that have been cultivated. The dominant soils are among the more fertile in the State and range from neutral to medium acid in the plowed layer, but normally have neutral subsoils and calcareous substrata. Phosphorus is consistently deficient but potash is in better supply than on most soils of the State. Practices for erosion control and for maintenance of organic matter are important. Drainage, too, is important locally on areas between the drumlins.

OH **Ontario–Hilton Association**—This association is west of Rochester on an undulating to gently rolling area of high-lime glacial till. Well- to moderately well-drained, medium-textured, high-lime soils are dominant. The well-drained Ontario soils are on moderately sloping convex topography. Ontario occupies from 30 to 60 percent of the association. The moderately well-drained Hilton soils, which occupy from 20 to 40 percent, are on very gently sloping areas that receive some water from higher-lying land. Both are medium-textured soils with slightly acid to medium-acid plowed layers but with lime in the substratum. Their poorly and very poorly drained associates are on flats and in depressions as minor constituents. Locally, nearly level areas of somewhat poorly drained, fine-textured Odessa soils are important inclusions.

The dominant soils of this association are well suited to a wide variety of crops including corn, small grains, hay, and most vegetables. The restricted internal drainage of Hilton imposes moderate restrictions on deep-rooted crops such as alfalfa and tree fruits. Maintenance of fertility is one of the most important problems. The lime requirement varies from none to moderate; free lime is in the substratum but surface soils may be acid. Phosphorus is uniformly deficient and potash, although moderately well supplied, may become deficient under

intensive cropping. In some areas, organic matter has been reduced seriously by intensive cropping. Erosion control is an important problem locally, and small areas of wet soil need drainage.

OL **Oquaga–Lackawanna Association**—This association occupies the steep hills and mountainous areas of southern New York where red shale and sandstone are the dominant kinds of bedrock. On the steep slopes are the shallow Oquaga soils, which occupy from 30 to 50 percent of the area. Locally Lordstown soils may replace Oquaga. The well-drained deep Lackawanna soils, which occupy from 15 to 30 percent, are on the steep or strongly sloping hillsides where the glacial till mantle is deepest. The moderately well-drained Wellsboro or Culvers soils are on gently to strongly sloping areas in the valleys. These series account for 15 to 30 percent of the association. In small seep areas on the hillsides are the poorly drained Morris soils. On the narrow valley floors, the well-drained gravelly Tunkhannock or silty Barbour occupy minor acreages.

Most of the area is forested and only locally in the valleys is there enough cultivable land to support a farm unit. Cultivable soil, where available, is suited mainly to crops grown in support of dairying and its soil-management problems are similar to those described for the Lackawanna-Wellsboro association.

OR **Ovid–Romulus Association**—The areas of this association are gently sloping. The soils were formed from moderately fine-textured calcareous glacial till high in either red shale or reworked reddish lake clays. Moderately fine texture and restricted internal drainage are outstanding characteristics of the dominant soils. The moderately well- to somewhat poorly drained Ovid soils, which occupy from 40 to 70 percent of the association, are on gentle uniform slopes. On nearly level areas or on gently sloping land where water accumulates is the poorly drained, moderately fine-textured Romulus, which occupies from 20 to 40 percent of the area. The well-drained Cazenovia on glacial till, the well drained Wampsville on red glacial outwash, and the very poorly drained Fonda soils in glacial till are important inclusions locally.

Although the dominant soils are among the more fertile of the State, moderately fine-texture and moderately to severely restricted internal drainage impose definite limitations on the choice of crops. Corn, small grains, and hay are best adapted. Alfalfa can be grown on the best drained parts of the Ovid soil and on the inclusions of Cazenovia and Wampsville. Drainage is an outstanding problem, and

maintenance of good structure requires special attention. Lime requirement ranges from none to moderate, and phosphorus is uniformly deficient. Potash is rarely deficient in the soils of this association. Erosion is not conspicuous on these gentle slopes, but it may be important locally on the most strongly sloping areas.

OS **Odessa–Schoharie Association**—The undulating to gently sloping areas of this association are dominated by reddish colored, fine-textured soils from clayey calcareous lacustrine deposits. On the parts with distinct but not steep slopes are the moderately well- to somewhat poorly drained Odessa soils, which occupy from 50 to 80 percent of the association. On the strongly sloping topography near streams are the well-drained heavy Schoharie soils. They occupy from 5 to 30 percent. On the level areas and in slight depressions, the poorly drained Lakemont and the very poorly drained Poygan soils appear as minor constituents. Soils developed in sands or in high-lime glacial till appear as minor inclusions that are important on some farms.

The association is fair or good for the crops of general and dairy farms, but poor for most vegetables and fruits sensitive to restricted internal drainage or subject to difficulty of seedling emergence. Winter wheat is one of the most productive small grains in these areas. Fertility maintenance is a moderate but not outstanding problem. Some areas need lime for legumes, and phosphorus is uniformly deficient. Usually, potash is adequate. Maintenance of good tilth is an important problem that involves care in maintenance of organic matter and in cultivation at the proper moisture content. Erosion control is important on all areas that are distinctly sloping. Nearly level areas need artificial drainage.

P **Palmyra, Kars, and Herkimer Associations**—All of these associations are dominated by well- to somewhat excessively drained soils from glacial outwash high in lime. From Syracuse and Cazenovia westward, the areas are from 70 to 95 percent Palmyra soils from glacial outwash dominated by limestone. The area south of Watertown is from 80 to 90 percent Kars soils from limestone gravel on a beach ridge. Kars soils are similar to Palmyra but have lime at a shallower depth. On the area in the Black River Valley, about 50 percent is Herkimer soils, which are developed in gravel and sand from calcareous black shale. The dominant soils of all of these areas are well drained, nearly neutral, moderate in water-holding capacity, and nearly level or very gently sloping. The associated soils of all three

associations are principally the poorly and very poorly drained members of the catena of the dominant soils.

The dominant soils of these areas are among the best of the State. They are adapted to almost all crops grown in the region, but are drouthy enough for yields to be increased by supplemental irrigation in dry years. Average yields over a period of years are good. The dominant soils need little lime, but do need phosphorus consistently and become potash deficient under intensive cropping. Erosion is not an important problem, and drainage is needed only on local areas of included soils.

PH **Plymouth–Haven Association**—These rolling to hilly areas on Long Island mark a prolonged stand of the glacial ice front. Although the material is considered glacial till, it is coarse and thus the association has been grouped with soils on gravel in the map legend. The soils are more or less sandy but are generally less drouthy than many adjacent areas. The moderately coarse textured Plymouth soils occupy about 50 percent of the association; Haven soils, about 35 percent. Sandy types of Bridgehampton or the very sandy Colton-like soils are important inclusions. Moderate drouthiness and uneven topography have limited agricultural development. Where cultivated, the dominant soils need very intensive fertilization and are only moderately productive.

PR **Panton–Rockland Association**—In this association, heavy, wet soils from marine clays are on low-lying flat areas among outcrops of solid bedrock. The poorly drained, nearly level heavy Covington or Panton soils occupy from 35 to 50 percent of the total area. Some of the areas between the bedrock outcrops are gently undulating, and on these are the moderately well- to somewhat poorly drained Vergennes soils, which occupy from 5 to 25 percent of the association. From 20 to 40 percent of the area is low-lying ridges or knolls of bedrock outcrops so distributed that the areas of deep soil are small and irregular in shape. Nevertheless, there are some farm units with enough deep soil areas to support a farm business.

As would be expected, the poorly drained Covington and Panton soils are suited mainly to hay, although open-ditch drainage makes it possible to grow corn and small grains on some areas. The better drained Vergennes soils can be used successfully without artificial drainage for crops in support of dairying. The dominant soils available for cropping are very clayey and are hard to work and to keep

in good tilth. Fertility maintenance is a moderate problem. Lime is needed on the best-drained parts, but the wettest, darkest colored soils rarely need lime. Potash is rarely inadequate, but phosphorus is uniformly deficient. Poor drainage, irregular-shaped fields, and poor soil structure are outstanding problems.

PT **Poland–Turin and Mohawk–Manheim Associations**—On these dominantly gently sloping or undulating areas are dark-colored soils from glacial till high in dark shale. Where the materials are mainly from calcareous black shale, the soils are nearly neutral and are of the Mohawk–Manheim association; where there is admixture of granitic or sandstone material, surface and subsoils have become acid and the soils of the Poland–Turin association are found. On the gently to moderately sloping areas with distinctly convex topography, are the well-drained, productive Poland or Mohawk soils. Each of these soils occupies from 25 to 50 percent of its association. On more uniform and more gently sloping topography is the moderately well- to somewhat poorly drained Turin or Manheim which occupy from 25 to 50 percent of their respective association. On the nearly level areas, the poorly drained Ilion occupies from 10 to 20 percent of both associations. The very poorly drained Fonda in shaly glacial till, the well-drained Nellis on limestone material, and the well-drained Herkimer on limestone and shale gravel appear as inclusions that are important locally.

Both associations are very productive of adapted crops if they are well managed. The dominant soils are well suited to corn, small grains, hay, and vegetables that are climatically adapted to the area. Maintenance of fertility is important, but not so outstanding as on most soils of the region. Lime is needed on the Poland but not on the Mohawk catena. Potash may be needed on the Poland but is rarely deficient on Mohawk. Phosphorus is needed on both. There is little evidence of erosion except on a few strongly sloping areas, but intensive use for intertilled crops would create a moderate general erosion problem. Drainage, too, is a moderate problem on most farms. The dominant soils of these areas have, however, good physical condition that permits high response to good management.

PV **Panton–Vergennes Association**—These areas are dominated by very gently sloping, wet, heavy soils from marine clays in association with better drained soils from similar material on undulating to gently rolling topography. On the nearly level or very gently sloping parts, are the poorly drained, very heavy Panton

or Covington soils, which occupy from 50 to 70 percent of the association. These soils are suited to few crops without some degree of artificial drainage. On the distinctly undulating or rolling parts are the moderately well- to somewhat poorly drained Vergennes soils. They occupy from 30 to 40 percent of the association. Vergennes soils may be used without artificial drainage for most crops grown in support of dairy enterprises. On absolutely level areas or in depressions, the very poorly drained Livingston soils from clay appear as minor constituents. Soils of various drainage conditions in sands over clay and soils from fine-textured recent alluvium also appear as important inclusions locally. The areas are nearly free of stones.

Hay, small grains, and corn for silage are the principal crops grown. Alfalfa is grown successfully on the best drained parts of the Vergennes, but it is poorly suited to Panton soils. In some areas the subsoils have a strongly expressed blocky structure that makes drainage by tile unusually effective for such heavy soils. This blocky structure is absent in some areas and these are very difficult to drain. Drainage to remove surface water is an important initial step in the general improvement of the association. Maintenance of fertility is an important but not an outstanding problem of the association. Lime is generally needed on Vergennes and Panton soils but is commonly not deficient on the dark-colored Covington. Phosphorus supply is consistently low, but rarely is potash deficient. Nitrogen deficiency is common throughout the association because legumes are difficult to maintain in the hay fields. There is some evidence of erosion on the Vergennes.

PW **Pittsfield, Wassaic, and Stockbridge Associations**—Most of the areas of this association are steep-sided valleys in which dominantly well-drained soils moderate to high in lime have developed on calcareous glacial till. The area adjacent to New Jersey is an exception. The Pittsfield, Wassaic, or Stockbridge soils may dominate in any one locality or they may be together. One or some combination of these three soils typically occupies from 60 to 80 percent of the association, but only about one-third of their area is deep, only moderately stony, and on slopes that are easily cultivable. Poorly and very poorly drained Kendaia and Lyons soils are minor constituents. Soils on glacial outwash, recent alluvium, and glacial till from slate may be important inclusions locally.

In most areas there is enough good soil suitable for cultivation to support dairy farms. On such farms, the steep, stony, or shallow areas of the valley sides are used for pasture or hay. The dominant soils on

moderate slopes are well suited to most hay crops, small grains, corn, and many vegetables. These soils have moderate fertility problems. They may need lime, invariably need phosphorus, and are typically potash deficient. Although there is not a large amount of severe erosion in these areas, which are dominated by sod crops, the more strongly sloping areas are subject to severe erosion when clean-cultivated.

RC **Rockaway–Chatfield Association**—This hilly association on granitic rock has deep glacial till in the valleys and shallow soils on the upper slopes of the hills. The soils are moderately coarse-textured, low in fertility, and very strongly acid. On the sloping to hilly topography where the glacial till is deep, are the well-drained Rockaway soils, which occupy from 30 to 60 percent of the association. On the steeper hills and on some rolling or hilly areas in the valleys, are the shallow Chatfield soils. They occupy from 20 to 50 percent of this association. Almost all areas are stony to some degree and about one-fifth are too stony for cultivation.

Crops grown in support of dairying are most important where cultivable soils are concentrated in areas large enough to support farm units, although cash crops can be produced. Yields are good only if an intensive fertility program is followed. The soils are deficient in all major nutrients and are very strongly acid. Much of the area is so near New York City that it is strongly influenced by urban development.

Rg **Rockland, Nearly Level to Sloping**—The soils of this association have so much rock outcrop that cultivation is feasible only in a few isolated areas. The outcrops may be limestone, sandstone, or granitic rock. The intervening soils are generally shallow and include soils from clay, glacial till, and sands in the various areas. Normally more than 50 percent is bare bedrock, although locally, where rock surfaces are nearly level, a uniform cover of soil material from 2 to 12 inches thick covers the rock. A few areas are used for pasture, which produces little. The larger areas, far from deep soil, are predominantly idle.

RM **Rhinebeck–Madalin Association**—The soils of this association are on nearly level to strongly sloping areas of grayish calcareous lacustrine silts and clays. They have silt loam surface texture but silty clay subsoils. On the undulating to strongly sloping distinctly convex topography are the moderately well- to

somewhat poorly drained Rhinebeck and the well-drained Hudson soils. These two series occupy from 35 to 60 percent of the association. On the nearly level areas are the poorly drained heavy Madalin soils, which occupy from 15 to 40 percent of the association. In slight depressions or in the middle of large flats, the clayey, very poorly drained Toledo soil is a minor constituent. Also, the sandy Colonie or Melrose, the gravelly Hoosic, and local areas of soils from glacial till may be important inclusions on a few farms. Most of the area has a slope less than 8 percent in gradient; but in a few places adjacent to streams, steep slopes dominate areas as large as an average farm unit. The area in Franklin County is more heterogeneous and generally less well drained than that in the Hudson Valley.

The agriculture in these areas is diversified, but there are distinct limitations in the choice of crops for the various soils. The well-drained Hudson soils, which are important locally, are productive of most crops adapted to the climate, including tree fruits and alfalfa. The moderately well- to somewhat poorly drained Rhinebeck soils are more extensive and are at least moderately well suited to most crops grown in support of dairying except those that root deeply or require early planting. The poorly drained Madalin is suited principally to hay and pasture unless some degree of artificial drainage has been established. Most farm units have moderate acreages of at least fair cropland. There are distinct management problems associated with the soil. For example, lime is generally needed, although there is lime in the substratum, and phosphorus, too, is a general requirement. Potash normally does not give high response except under intensive cropping. Poor soil structure is one of the most important problems, and practices designed to maintain organic matter are very important. Erosion is serious on moderate to strong slopes, and drainage is badly needed on the nearly level areas.

Rs **Rockland, Steep**—These are hilly and steep areas on which rock outcrop and very shallow soil occupy more than 75 percent of the association. Local pockets of deep soil are among the rocks and support some vegetative cover. The Chatfield, Nassau, and Hollis soils are most common among the bedrock outcrop. This association is almost entirely non-agricultural and mainly forested.

SB **Sacandaga–Ballston Association**—This association occupies an undulating to gently rolling glacial till plain where granitic material from the Adirondack Mountains is mixed with limestone and shale of the locality. The dominant soils are well- and moderately well-drained and strongly acid, with neutral or slightly acid fragipans. The well-drained, medium-textured Sacandaga soils are on gentle to moderate slopes with distinctly convex form. Sacandaga occupies from 35 to 60 percent of the association. Its moderately well-drained associate, Ballston, on the gentle but distinct slopes where moderate amounts of water accumulate, occupies from 25 to 50 percent of the area. The poorly drained soils of the same catena and soils from glacial outwash appear as minor inclusions.

This association is potentially productive of most crops but requires intensive fertilization and liming. The dominant soils have a rooting zone with good physical properties above the fragipan and respond well to treatment. Lime, phosphorus, and potash are consistently deficient. Locally, stoniness limits land use, and moderate stoniness is a general problem throughout the area. There is some evidence of erosion, but severe erosion is not general under the existing agriculture. It can be serious where intertilled crops are grown frequently on the more strongly sloping areas. Drainage is a moderate problem locally.

SI **Sodus–Ira Association**—The soils of this association are on undulating to rolling topography when the till is dominated by sandstone that contained some lime. Locally drumlins appear as conspicuous features of the landscape. The dominant soils are strongly acid, and have moderately to strongly expressed fragipans below 18 to 30 inches. On the distinctly undulating to rolling parts are the well-drained Sodus soils. These occupy from 30 to 60 percent of the association. The moderately well-drained Ira soils on gently undulating slightly convex slopes occupy from 25 to 50 percent of the area. On the nearly level areas, the somewhat poorly drained Scriba may occupy from 5 to 15 percent of the association. Soils of the Colosse, Amboy, and Windsor catenas are important inclusions on some farms.

Although most crops adapted climatically can be grown with moderate to high production under best management, low fertility limits the existing agriculture. The soils are very low in lime, phosphorus, and potash; and, without liberal use of these materials, yields are far below the potential of the association. Stoniness is a major problem throughout much of the area, and in some places limits the intensive use of these soils. There is little evidence of severe erosion for the

area as a whole, but it may be important locally if the steeper slopes are cropped intensively. Although drainage is generally somewhat restricted throughout the area, it is a major problem only where the areas of Scriba soils are concentrated.

SN **Salmon—Nicholville Association**—The exceptionally good physical condition of the plowed layer in these areas is impressive. Well- and moderately well-drained soils in lacustrine silts and very fine sands on moderate to gentle slopes are dominant. On the convex moderately to strongly sloping areas, are the well-drained Salmon soils. They occupy from 20 to 50 percent of the association. The moderately well-drained Nicholville on the more uniform but distinctly sloping areas occupies a similar proportion. These are both silty, strongly acid soils that are almost stone-free. Locally these soils are only moderately deep over glacial till, and these areas may have some loose stones within the plowed layer. Somewhat poorly or poorly drained soils of the Salmon catena or soils from glacial till may appear as minor constituents.

The dominant soils, potentially highly productive of almost all crops adapted to the climate, are low in fertility and yield poorly under poor management. The principal soils are deficient in lime, phosphorus, and potash, but they are exceptionally responsive to fertilization and liming. Locally, vegetable and potato production is intensive under very high rates of fertilization. Although organic matter and nitrogen are generally high, nitrogen is released slowly in the cool climate and must be supplied for high yields of most crops. There is considerable evidence of erosion in intensively cultivated areas. Both the Salmon and Nicholville soils are very erodible even on mild slopes.

T **Toledo, Poygan, and Lorain Associations**—All of these three associations are dominated by very wet clays and differ only in relatively minor ways. They are on nearly level areas. More than 40 percent is the very poorly drained soil of the Toledo, Poygan, or Lorain series. From 20 to 40 percent may be the poorly drained member of the same catena. Locally there are important inclusions of better drained soils on glacial outwash or recent alluvium, and these areas may support good farm businesses.

Without artificial drainage these areas are largely too wet for agricultural use. The heavy wet soils are difficult to drain. In some places open ditches have removed surface water enough to permit use of the wet soils for hay or pasture, and there are some good farms on the better drained inclusions. Lime and potash are generally not needed on the dominant soils, but phosphorus is uniformly deficient.

TB **Tunkhannock–Basher Association**—Areas of this association are on the valley floors in the region of red soils from the Catskill Mountains westward and are comparable to those of the Chenango-Tioga association. The soils have inherited reddish colors from red shale and sandstone material. The deep well-drained Tunkhannock soils are on the nearly level glacial outwash terraces. They occupy from 40 to 60 percent of most areas. On the first bottomlands along the stream, are the moderately well-drained Basher and the well-drained Barbour soils. These two soils together occupy from 20 to 70 percent of the association. On the first bottomland far from the river or in local depressions of the terraces are poorly drained soils that may occupy as much as 20 percent of some areas. Chenango soils replace Tunkhannock in the association locally.

The dominant soils are productive of all crops common to the area, although they are very strongly acid and are low in both phosphorus and potash. These soils have good moisture-supplying capacity, however, and response to lime and fertilizer is high. There are few conservation problems other than maintenance of organic matter and fertility.

TC **Troy–Cossayuna Association**—This is the dominant association on the undulating to rolling glacial till plain of the Hudson Valley. Locally drumlins are prominent features of the landscape. Although slates are dominant in the parent material, limestone or calcareous sandstone has contributed enough to make the substratum mildly calcareous. The soils are leached of lime to depths ranging from 4 to more than 10 feet, and the surface soils are among the most acid in the State. The dominant soils have pan-like horizons moderately high in clay at depths ranging from 15 to 25 inches. On the distinctly convex but moderately sloping areas is the moderately well-drained Troy. It occupies from 20 to 40 percent of the association. The well-drained Cossayuna on the more strongly sloping areas or the crests of drumlins accounts for 15 to 30 percent of the association. The two combined typically occupy from 40 to 70 percent of the total area. On the gently sloping areas where seepage water accumulates, the somewhat poorly drained Albia soils predominate. They account for 5 to 15 percent of the association. On the nearly level flats or in slight depressions, the poorly drained Boynton appears as a minor constituent. Locally the shallow Nassau soils are important inclusions that are dominant in areas as large as an average-sized farm. In the valleys the Hoosic soils appear on gravel as important inclusions. Generally the areas are steepest adjacent to the New England uplands.

Although the dominant soils are potentially productive of almost all crops adapted to the climate, intensive fertilization and liming are necessary for good yields. Lime, phosphorus, and potash are deficient, and the response of most crops to these is high, because the physical conditions of the upper part of the soil are good. Locally stoniness limits land use of moderate-sized areas, but the major part of the association is only moderately stony. There is much evidence that past erosion has been serious. Under the present cropping system, however, sod crops provide control in most areas. On this complex topography, intensive cropping is usually associated with excessive erosion and the uneven relief characteristic of the area limits the use of contour devices for its control.

U **Undifferentiated Urban Land**—This land includes the large cities and their suburbs where building and excavation have greatly modified the original soil conditions.

VM **Volusia–Mardin Association**—This important soil association has a reputation as one of the major problem areas of southern New York. It presents a landscape of broad till-covered hills whose long uniform slopes are predominantly somewhat poorly drained. The dominant soils have strongly expressed fragipans at 12 to 18 inches, and are slow to dry in the spring and low in fertility. On the long uniform slopes, most of which are gently to moderately sloping, are the somewhat poorly drained Volusia soils. They occupy from 40 to 70 percent of the association. On the distinctly convex, moderately to strongly sloping parts, the moderately well-drained Mardin predominates. It occupies from 15 to 35 percent. On small concave areas on the hillsides is the poorly drained Ellery soil. Although it occupies only from 1 to 10 percent of the total association, on many farms it is so located within fields that it controls the time at which the fields can be worked. These "seep" spots are to a considerable degree the cause for the reputation of the area. Long, narrow areas of steep shallow Lordstown soils appear as important inclusions locally.

Historically drainage has been an outstanding problem of the association. If the seep spots are absent or can be drained, the Volusia and Mardin soils are adapted to corn, small grains, and hay exclusive of alfalfa. For even moderate yields, however, heavy liming and relatively intensive fertilization are necessary. Phosphorus is consistently deficient, and potash becomes less plentiful as yields are increased by other practices. Many hay fields have poor stands of legumes and as a

result nitrogen deficiency is an important problem. There is evidence of erosion in many places. The long slopes accumulate a large amount of runoff, especially when the soils are saturated above the pan, and this creates an erosion hazard although the soil material itself is not highly erodible. Although good production can be obtained on these soils, it is at considerably greater cost than on the better drained and more fertile associations of the region.

VP **Vergennes–Panton Association**—This area has very heavy soils developed from clays that were deposited in an ancient arm of the sea. Topography is distinctly undulating or rolling in contrast to the Panton-Vergennes association of the same region. On the distinctly convex, undulating or rolling relief, the moderately well- to somewhat poorly drained clayey Vergennes soils predominate. They occupy from 40 to 60 percent of the association. On the nearly level areas (from 15 to 30 percent of the association) the poorly drained light-colored Panton or the poorly drained dark-colored Covington soils are found. Locally, somewhat poorly to moderately well-drained soils from glacial till or soils developed in sands over clay are important inclusions.

These areas are fair to good for the common crops of dairy farms but poor for most vegetables and fruits. Alfalfa is well adapted on the best drained sites. The dominant soils are generally deficient in lime and phosphorus, but potash is not normally a limiting nutrient. These soils are difficult to work and hard to keep in good physical condition. There is some erosion on the stronger slopes where cropping has been most intensive. Artificial drainage in some degree has been established on the nearly level Panton and Covington areas that are used for crops other than hay.

W **Windsor and Hinckley Associations**—The soils of this association are coarse-textured, nearly level to undulating, and in gravel of glacial outwash terraces or in sand of deltas. On both the level and undulating areas, the very drouthy, very strongly acid Windsor soils in sands or the Hinckley soils in gravel dominate. One of these two series occupies from 60 to 85 percent of most areas and dominates land use. Locally, the Windsor soils are only moderately deep over clay and are less drouthy than normal. In distinctly low-lying nearly level areas are found somewhat poorly and poorly drained soils in gravel or sand. They constitute from 0 to 30 percent of the area. Soils from clay or from glacial till may be minor inclusions locally.

SOIL ASSOCIATION MAP of NEW YORK STATE

Compiled by M. G. Cline, Department of Agronomy, Cornell University
1953

LEGEND

Areas Dominated by Coarse-textured Soils on Gravel and Sand

Dominantly Well- to Excessively Drained Nearly Level Soils

- A — Alton, Colosse, and Ottawa associations
- C — Colton and Adams associations
- Co — Colonie and Otisville associations
- W — Windsor and Hinckley associations

Dominantly Somewhat Poorly Drained Soils

- CCo — Claverack - Colonie association
- ES — Elmwood - Swanton association

Dominantly Poorly and Very Poorly Drained Soils

- JG — Junius - Granby association

Dominantly Excessively Drained Hilly Soils

- Ah — Alton, Colosse, Hinckley, and Colton associations hilly areas

Areas Do…ated by Medium to Moderately Coarse-textur… Soils on Gravel and Recent Alluvium

Dominantly …drained Nearly Level Soils

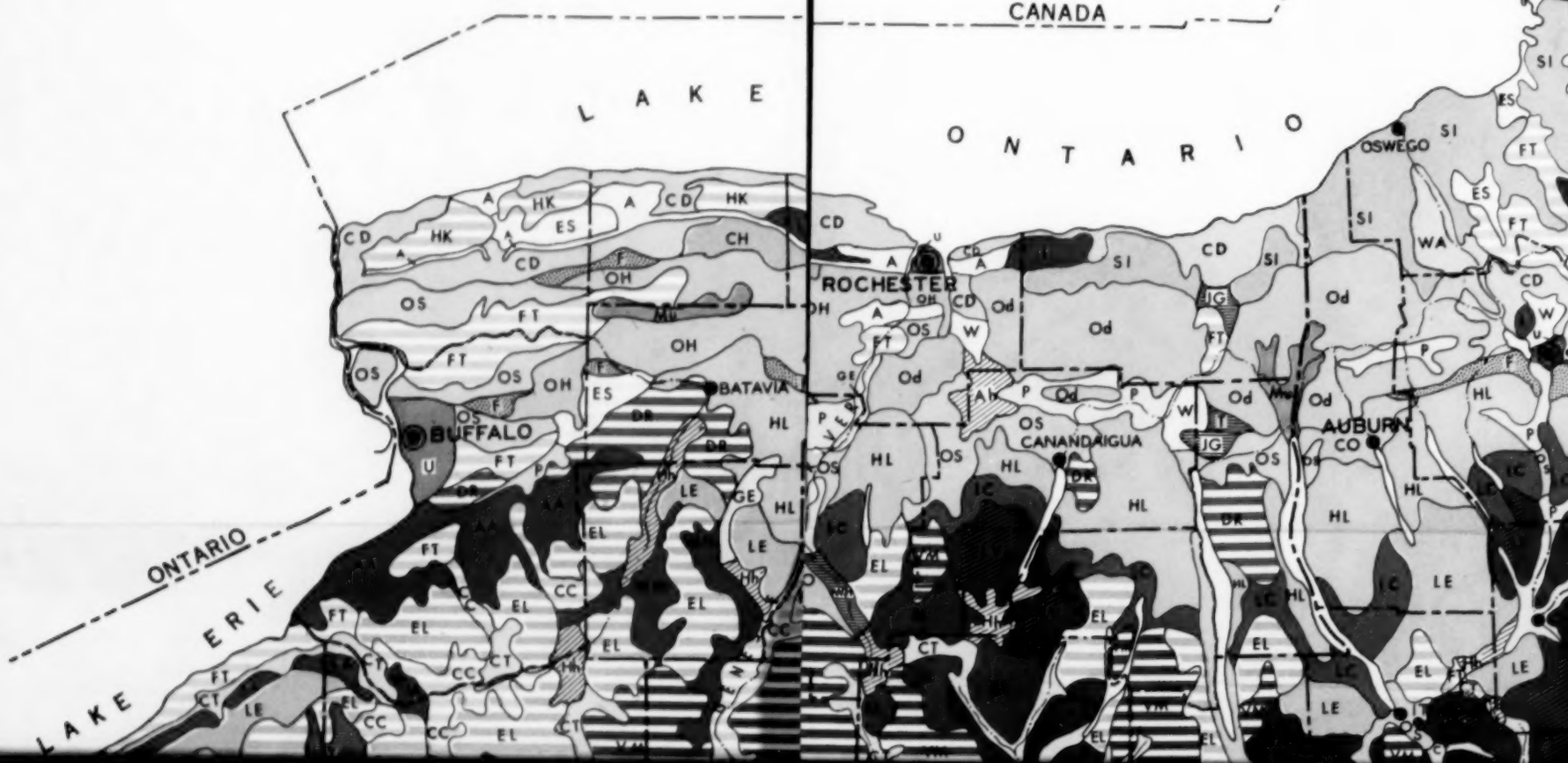
- Bf — …dgehampton fine sandy loam association
- Bl — …dgehampton loam association
- CT — …enango - Tioga and Howard - Chagrin associations
- GE — …nesee - Eel association
- H — …osic association
- HB — …mpstead - Bridgehampton association
- P — …myra, Kars, and Herkimer associations
- TB — …nkhannock - Basher association

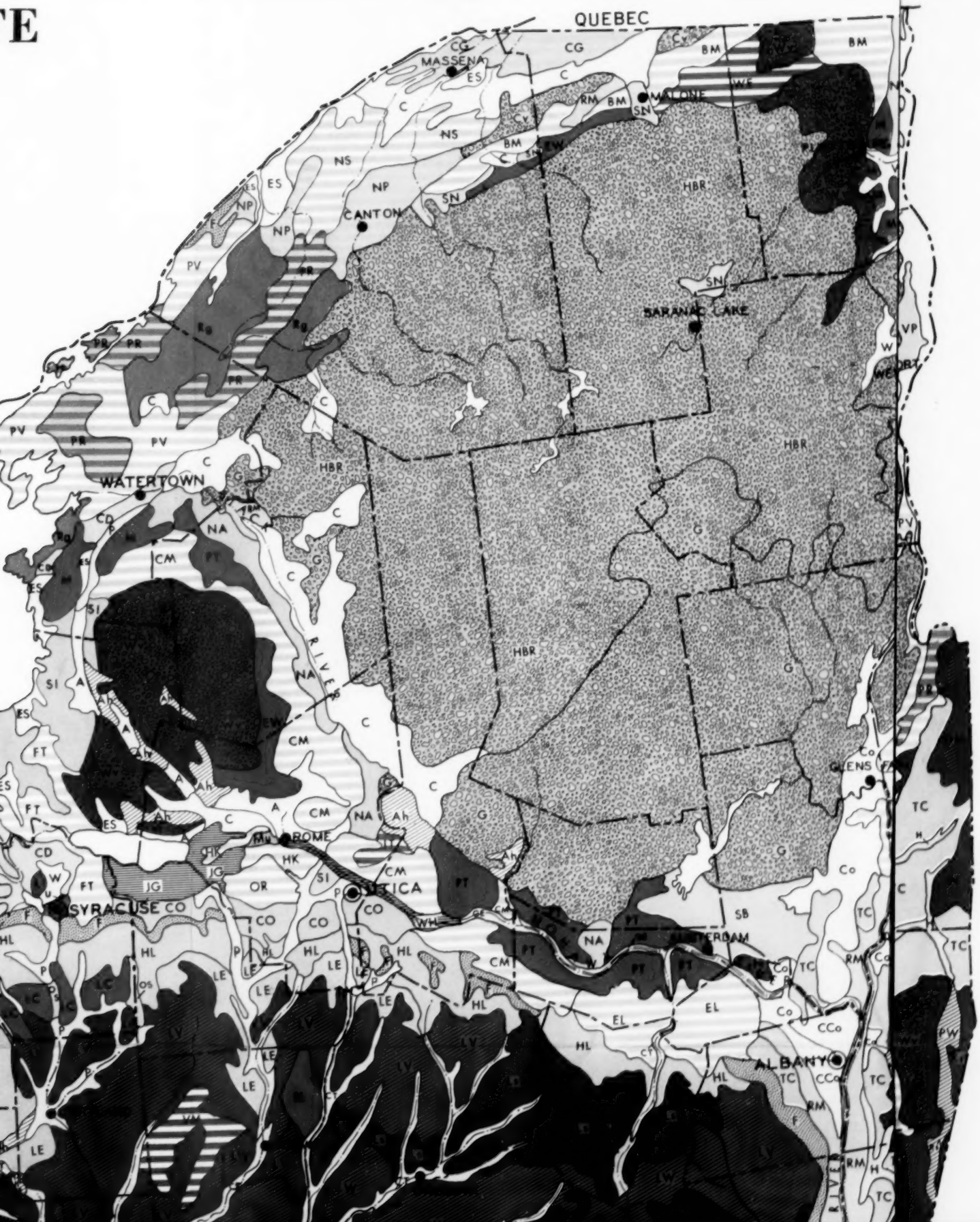
Dominantly …y and Very Poorly Drained Soils

- WH — …ayland - Eel and Holly - Middlebury associations

Dominantly S…what Excessively Drained Hilly Soils

- Hh — …oward, Hoosic, Chenango, and Arkport associa…ns, hilly areas
- PH — …rmouth - Haven association





TE

Deep and Shallow Soils Asso

CHW — Charlton - Holl

DM — Dutchess - Mac

LV — Lordstown - Ve

Dominantly Shallow Undulati

N — Nassau, Macon

Dominantly Steep Shallow So

— Lordstown asso

— Catskill and W

Dominantly Very Stony Soils

— Worth - Empey

Areas Dominated by De
with Strongly Acid Fragip
Sandstone and Shale or by

Dominantly Deep Well- and
Gently to Strongly Sloping So

CCM — Cattaraugus - C

Deep and Shallow Soils Assoc

LW — Lackawanna - V

Dominantly Steep Shallow So

— Oquaga - Lacka

Areas Dominated by M
Strongly Acid Soils on G

Deep and Shallow Soils Assoc

RC — Rockaway - Ch

Dominantly Very Stony Soils

G — Gloucester - Es

HBR — Hermon - Beck

Areas Dominated by N
on Glacial Lake

Dominantly Well- to Somewh

CD — Collamer - Dun

OS — Odessa - Schoh

RM — Rhinebeck - Ma

SN — Salmon - Nicho

VP — Vergennes - Pa

WA — Williamson - A

Dominantly Somewhat Poorly

CC — Canadea - Can

FT — Fulton - Toled

CIATION MAP of NEW YORK STATE

piled by M. G. Cline, Department of Agronomy, Cornell University
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Sand

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Areas Dominated by Medium to Moderately Coarse-textured Soils on Gravel and Recent Alluvium

Dominantly Well-drained Nearly Level Soils

- Bf — dgehampton fine sandy loam association
- Bl — dgehampton loam association
- CT — enango - Tioga and Howard - Chagrin associations
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- P — lmyra, Kars, and Herkimer associations
- TB — nkhannock - Basher association

Dominantly Poorly and Very Poorly Drained Soils

- WH — ayland - Eel and Holly - Middlebury associations

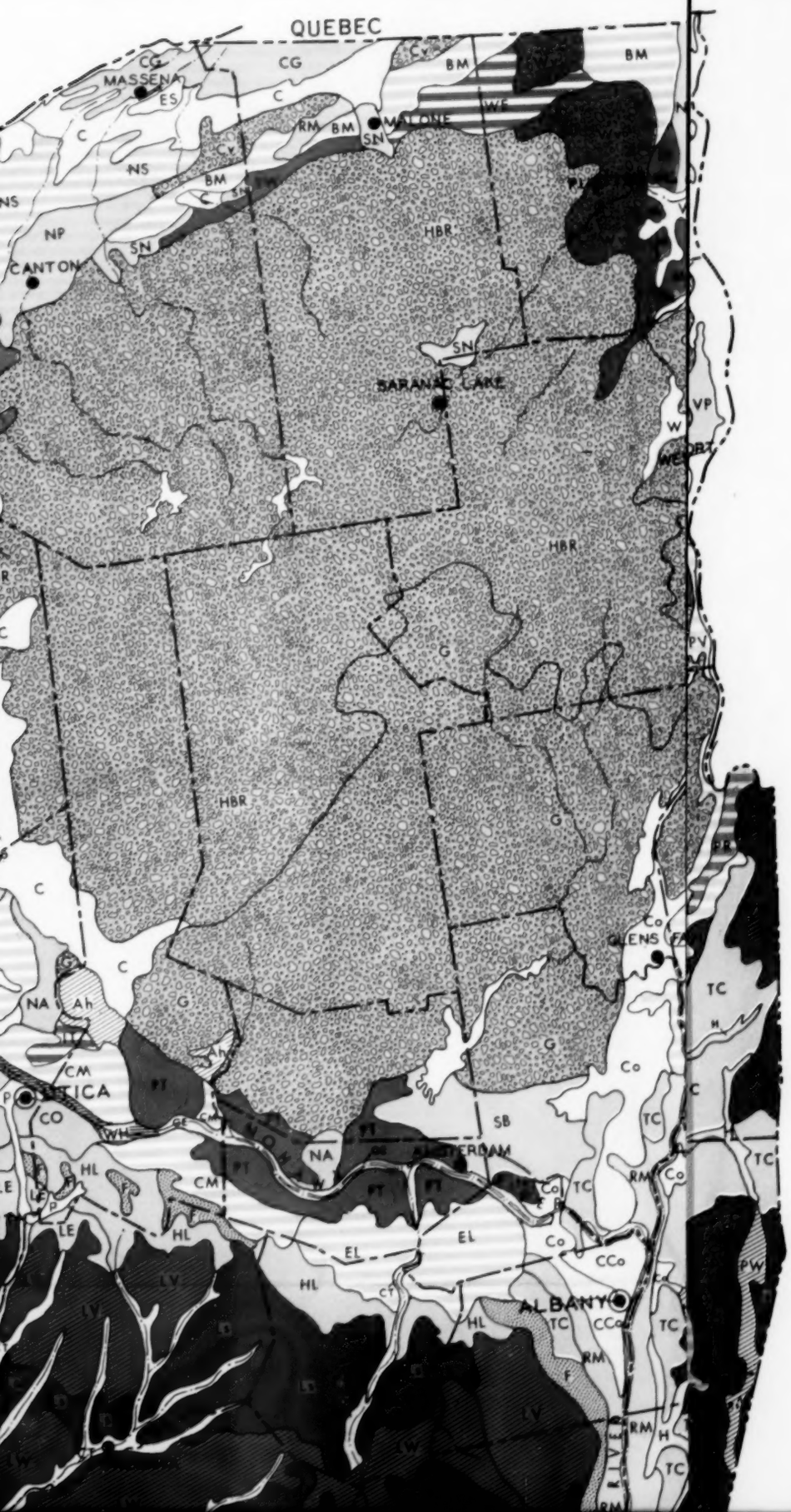
Dominantly Somewhat Excessively Drained Hilly Soils

- Hh — oward, Hoosic, Chenango, and Arkport associations, hilly areas
- PH — mouth - Haven association

CANADA

L A K E O N T A R I O

WATERTOWN
CANTON
OSWEGO
ROME
SYRACUSE
AUBURN
ROCHESTER
BATAVIA
BUFFALO
CANANDAIGUA
HBR
RIVER



Deep and Shallow Soils Associated in Hilly Areas

— Charlton - Hollis - Woodbridge association

— Dutchess - Macomber association

— Lordstown - Volusia association

Dominantly Shallow Undulating to Hilly Soils

— Nassau, Macomber, and Manlius associations

Dominantly Steep Shallow Soils

— Lordstown association

— Catskill and Wurtsboro associations

Dominantly Very Stony Soils

— Worth - Empeyville - Westbury association, very stony

Areas Dominated by Deep Medium-textured Acid Soils with Strongly Acid Fragipans on Glacial Till from Reddish Sandstone and Shale or by Shallow Soils from Similar Rocks

Dominantly Deep Well- and Moderately Well-drained Gently to Strongly Sloping Soils

— Cattaraugus - Culvers - Morris association

Deep and Shallow Soils Associated in Hilly Areas

— Lackawanna - Wellsboro association

Dominantly Steep Shallow Soils

— Oquaga - Lackawanna association

Areas Dominated by Moderately Coarse-textured Very Strongly Acid Soils on Glacial Till from Granitic Rocks

Deep and Shallow Soils Associated in Hilly Areas

RC — Rockaway - Chatfield association

Dominantly Very Stony Soils on Rolling to Steep Topography

G — Gloucester - Essex - Rockland association

HBR — Hermon - Becket - Rockland association

Areas Dominated by Medium- to Fine-textured Soils on Glacial Lake or Marine Sediments

Dominantly Well- to Somewhat Poorly Drained Soils

CD — Collamer - Dunkirk association

OS — Odessa - Schoharie association

RM — Rhinebeck - Madalin association

SN — Salmon - Nicholville association

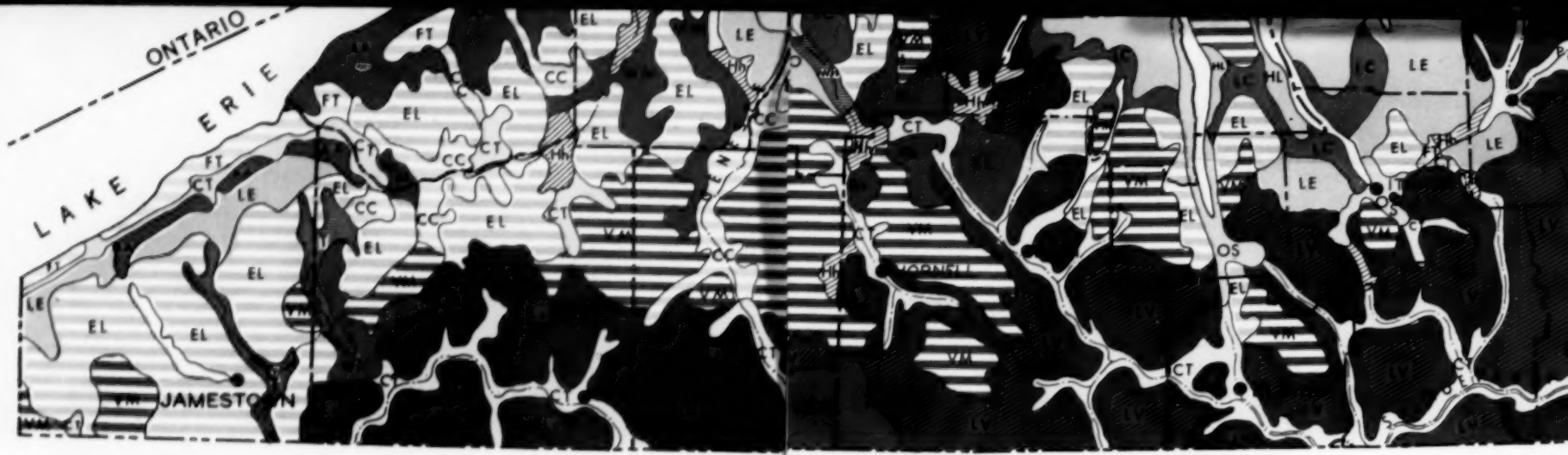
VP — Vergennes - Panton association

WA — Williamson - Amboy association

Dominantly Somewhat Poorly and Poorly Drained Soils

CC — Caneadea - Canadice association

FT — Fulton - Toledo association



Areas Dominated by Medium and Moderately Fine-textured High-lime Soils on Glacial Till or by Their Shallow Associates

Dominantly Deep Well- and Moderately Well-drained Undulating to Sloping Soils

- CO — Cazenovia - Ovid association
- HL — Honeoye - Lima association
- NA — Nellis - Amenia association
- Od — Ontario association, drumlin areas
- OH — Ontario - Hilton association

Dominantly Deep Moderately Well- to Somewhat Poorly Drained Soils

- HK — Hilton association
- OR — Ovid - Romulus association

Dominantly Shallow Soils

- F — Farmington and Nellis associations

Dominantly Deep Well-drained Hilly Soils

- PW — Pittsfield, Wassaic, and Stockbridge associations

Well-drained Soils from Till Interspersed with Wet Soils from Marine Clays

- NP — Nellis - Panton association

Well-drained Soils from Till Interspersed with Wet Soils from Sands

- NS — Nellis - Swanton association

Areas minated by Medium- and Moderately Fine tured Medium- and Low-Lime Soils out Fragipans on Glacial Till or by Their Shallow Associates

Dominantly Well- and Moderately Well-drained Undulating oping Soils

- LC — nsing - Conesus association
- M — adrid - Bombay and Madrid - Collamer associations
- PT — oland - Turin and Mohawk - Manheim associations

Dominantly to Moderately Deep Somewhat Poorly and Poorly ned Soils

- DR — arien - Romulus association
- VT — on - Turin association

Dominantly ow Somewhat Poorly Drained Moderately Fine-texture ls

- AA — urora - Angola association
- L — ockport association

Areas inated by Medium-textured Acid Soils With Ne to Slightly Acid Fragipans on Glacial Till

Dominantly Well- or Moderately Well-drained Undulating oping Soils

- CH — arkson - Hulberton association
- LE — ngford - Erie association

- SB — Sacandaga - Balls
- SI — Sodus - Ira associ
- TC — Troy - Cossayuna

Dominantly Somewhat Poorly D

- Ap — Alps association
- BM — Brayton - Moira
- CM — Camroden - Marc
- EL — Erie - Langford a

Dominantly Poorly Drained Ve

- Cv — Coveytown - Coo

Areas Dominated by De Coarse-textured Acid Fragipans on Glacial Till Slate, or Schist, or by Sha

Dominantly Deep Well- and Mo Gently to Strongly Sloping Soil

- — Bath - Mardin - L
- — Empeyville - Wes
- WM — Woostern - Mard

Dominantly Somewhat Poorly D

- VM — Volusia - Mardin
- — Westbury - Empe

aga - Ballston association
- Ira association
Cossayuna association

t Poorly Drained Soils
ssociation
n - Moira association
den - Marcy association
Langford association

rained Very Stony Soils
own - Cook association

d by Deep Medium- to Moderately
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or by Shallow Soils from Similar Rocks

ll- and Moderately Well-drained
pping Soils
Mardin - Lordstown association
ville - Westbury association
ern - Mardin association

t Poorly Drained Soils
- Mardin association
ry - Empeyville association

SN — Salmon - Nicholvill
VP — Vergennes - Panton
WA — Williamson - Ambo

Dominantly Somewhat Poorly and

CC — Canadea - Canadic
FT — Fulton - Toledo ass
PV — Panton - Vergennes

Dominantly Very Poorly Drained

T — Toledo, Poygan, a

Poorly Drained Clayey Soils Amo

CG — Covington - Grenvi

Poorly Drained Clayey Soils Amo

PR — Panton - Rockland

Areas Dominated by Rockl

Rg — Rockland, nearly le
Rs — Rockland, steep

Miscellane

Mu — Muck
U — Undifferentiated ur

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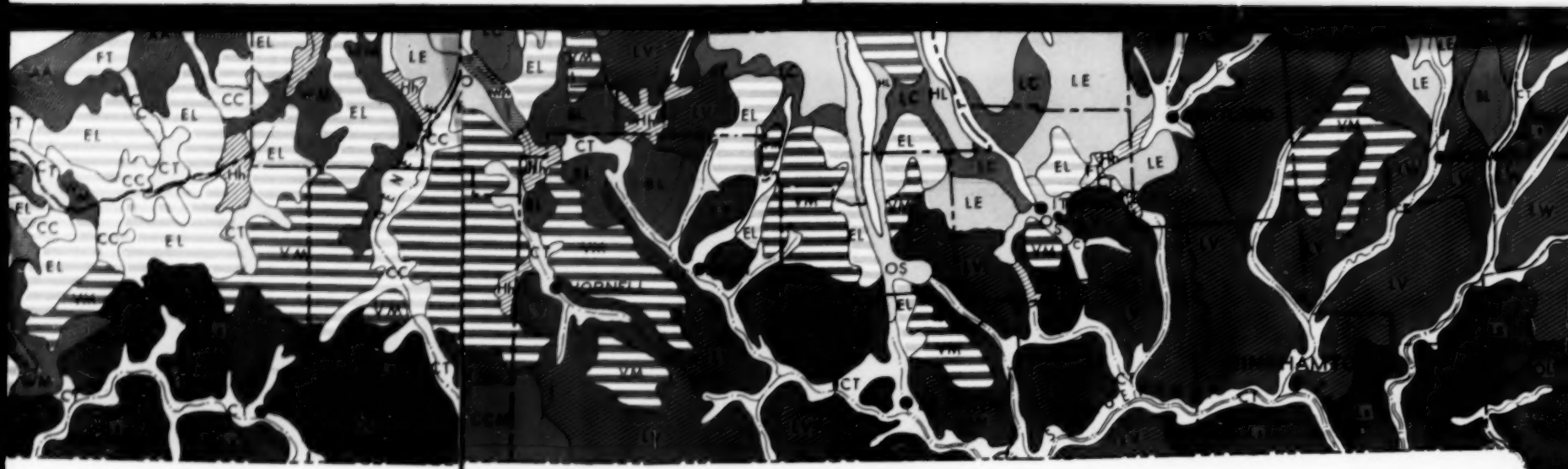
a unit of the State University of New York,
at Cornell University

SN — Salmon - Nicholville association



Areas Dominated by Medium- and Moderately Fine-textured Medium- and Low-Lime Soils Without Fragipans on Glacial Till or by Their Shallow Associates

Dominantly Well- and Moderately Well-drained Undulating Sloping Soils

- LC — Lansing - Conesus association
- M — Madrid - Bombay and Madrid - Collamer associations
- PT — Poland - Turin and Mohawk - Manheim associations

Dominantly to Moderately Deep Somewhat Poorly and Poorly Drained Soils

- DR — Darien - Romulus association
- VT — Lyon - Turin association

Dominantly Somewhat Poorly Drained Moderately Fine-textured Soils

- AA — Aurora - Angola association
- L — Lockport association

Areas Dominated by Medium-textured Acid Soils With Neutral to Slightly Acid Fragipans on Glacial Till

Dominantly Well- or Moderately Well-drained Undulating Sloping Soils

- CH — Clarkson - Hulberton association
- LE — Langford - Erie association
- SB — Sacandaga - Ballston association
- SI — Sodus - Ira association
- TC — Troy - Cossayuna association

Dominantly Somewhat Poorly Drained Soils

- Ap — Alps association
- BM — Brayton - Moira association
- CM — Camroden - Marcy association
- EL — Erie - Langford association

Dominantly Poorly Drained Very Stony Soils

- Cv — Coveytown - Cook association

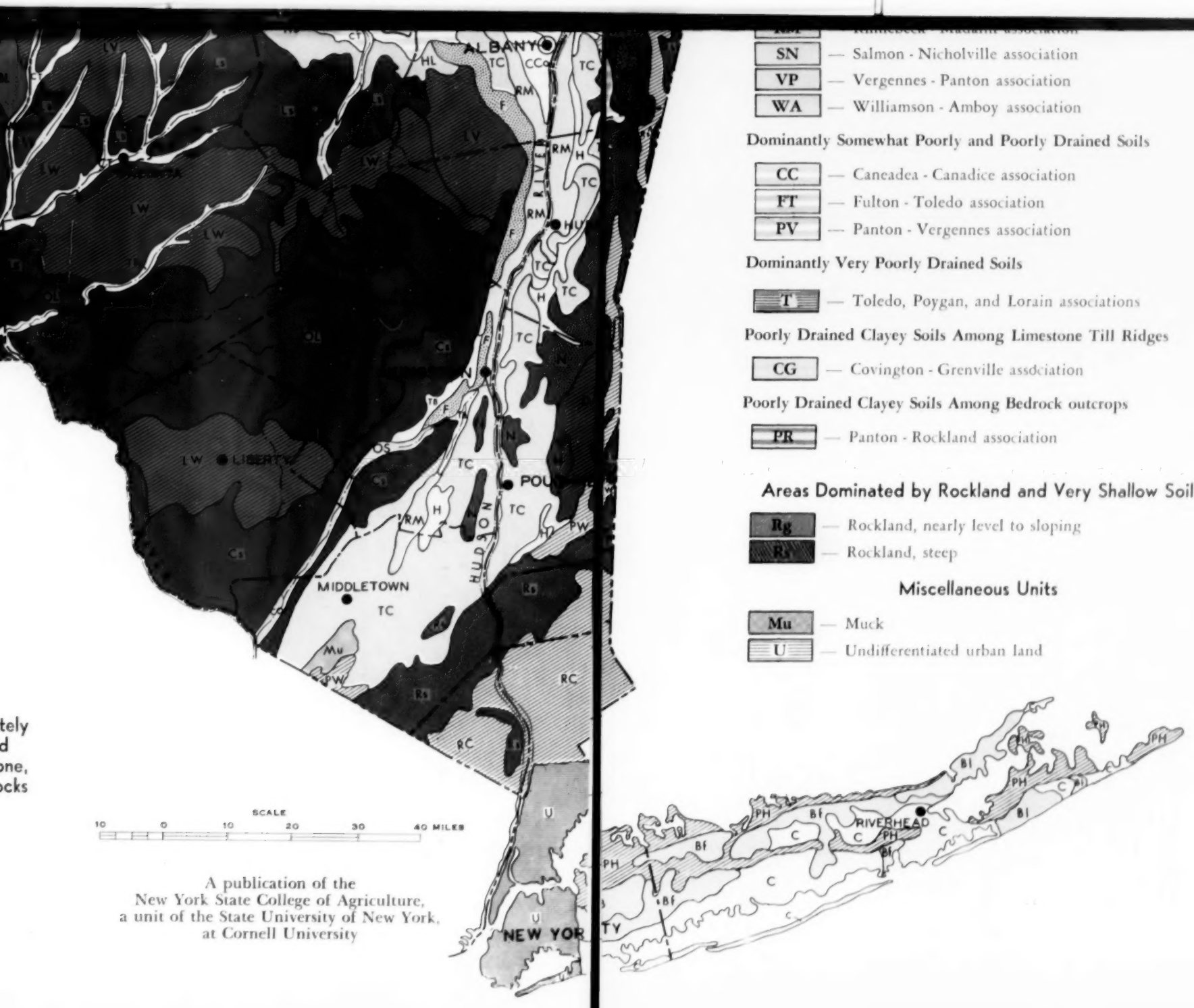
Areas Dominated by Deep Medium- to Moderately Coarse-textured Acid Soils with Strongly Acid Fragipans on Glacial Till from Gray Shale, Sandstone, Slate, or Schist, or by Shallow Soils from Similar Rocks

Dominantly Deep Well- and Moderately Well-drained Gently to Strongly Sloping Soils

- BL — Bath - Mardin - Lordstown association
- EW — Empeyville - Westbury association
- WM — Woostern - Mardin association

Dominantly Somewhat Poorly Drained Soils

- VM — Volusia - Mardin association
- WE — Westbury - Empeyville association



SN — Salmon - Nicholville association

VP — Vergennes - Panton association

WA — Williamson - Amboy association

Dominantly Somewhat Poorly and Poorly Drained Soils

CC — Caneadea - Canadice association

FT — Fulton - Toledo association

PV — Panton - Vergennes association

Dominantly Very Poorly Drained Soils

T — Toledo, Poygan, and Lorain associations

Poorly Drained Clayey Soils Among Limestone Till Ridges

CG — Covington - Grenville assdciation

Poorly Drained Clayey Soils Among Bedrock outcrops

PR — Panton - Rockland association

Areas Dominated by Rockland and Very Shallow Soils

Rg — Rockland, nearly level to sloping

Rs — Rockland, steep

Miscellaneous Units

Mu — Muck

U — Undifferentiated urban land

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Key to the Soil Series of New York

PARENT material of the soil catena and selected soil characteristics of the best-drained member	Line	Soil-drainage class: Good or excessive	Moderately good	Somewhat poor	Poor	Very poor
A. SOILS FROM GLACIAL TILL						
1. On the Adirondack Highlands and New England Uplands						
a. Limestone material						
(1) Brown Forest soils, medium texture						
(a) Brown color	1	Pittsfield	Amenia	Kendaia	← →	Lyons
(b) Reddish color	2	Dover	Amenia	Kendaia	← →	Lyons
(2) Gray Brown Podzolic soils, medium texture	3	Wassaic		Kendaia	← →	Lyons
b. Granitic rock material (soil groups listed from warm to cool climate)						
(1) Acid Brown Earths, moderately coarse texture						
(a) Shallow soils	4	Chatfield				
(b) Deep soils, strong fragipans	5	Rockaway				
(2) Weak Podzols, moderately coarse texture						
(a) Shallow soils	6	Shapleigh				
(b) Deep soils, weak or no fragipans	7	Gloucester	Acton	← →	Leicester	Whitman
(c) Deep soils, strong fragipans	8	Essex	Scituate	← →	Ridgebury	Whitman
(3) Strong Podzols, moderately coarse texture						
(a) Shallow soils	9	Canaan				
(b) Deep soils, weak or no fragipans	10	Hermon	Waumbek	← →	Leicester	Whitman
(c) Deep soils, strong fragipans	11	Becket	Skerry	← →	Ridgebury	Whitman
c. Schist or phyllite material						
Weak Podzols, medium texture						
(a) Shallow soils	12	Hollis				
(b) Deep soils, weak or no fragipans	13	Charlton	Sutton	← →	Leicester	Whitman
(c) Deep soils, strong fragipans	14		Woodbridge	← →	Ridgebury	Whitman
2. In the Hudson Valley						
a. Limestone material						
(1) Brown Forest soils, medium texture						
(a) Brown color	15	Nellis	Amenia	Kendaia	← →	Lyons
(b) Reddish color	16	Dover	Amenia	Kendaia	← →	Lyons
(2) Gray Brown Podzolic soils, medium texture	17	Wassaic				
b. Limestone and slate material mixed						
Weak Podzol, medium texture	18	Stockbridge				
c. Slate and shale material						
(1) Acid Brown Earths, medium texture						
(a) Shallow soils	19	Nassau				
(b) Deep soils, moderate fragipans	20	Cossayuna				
(c) Deep soils, strong clayey fragipans	21		Troy	Albia	Boynton	Burnham
(c) Deep soils, strong clayey fragipans	24		Bernardston	Pittstown	Stissing	Mansfield
(3) Gray Brown Podzolic soils, medium texture						
Reddish color from red slate	25			Alps		
d. Sandstone material						
(1) Acid Brown Earths, medium texture						
(a) Shallow soils on calcareous sandstone	26	Staatsburg				
(b) Deep soils, moderate fragipans	27	Swartswood				
(c) Deep soils, strong fragipans	28		Wurtsboro			
(2) Podzols, moderately coarse texture						
Deep soils with fragipans	29	Worth	Empeyville	Westbury	Dannemora	Tughill
3. In the St. Lawrence and Champlain Valleys—arranged as found in going from limestone to sandstone areas						
a. Limestone material						
(1) Brown Forest soils						
(a) Moderately coarse texture	30	Grenville	Hogansburg	← →	Massena	Sun
(b) Medium texture	31	Nellis	Amenia	Kendaia	← →	Lyons
(2) Gray Brown Podzolic soils, medium texture	32	Madrid	Bombay	Kendaia	← →	Lyons
b. Sandstone and limestone material mixed						
(1) Weak Podzols, coarse texture, wave-sorted till	33	Trout River	Fahey		Coveytown	Cook
(2) Podzols, moderately coarse texture						
Deep soils with fragipans, wet soils neutral	34	Parishville	Moira	Brayton	Massena	Sun
c. Sandstone material—moderately coarse-texture						
Podzols with fragipans	35	Worth	Empeyville	Westbury	Dannemora	Tughill
4. In the Black River and Mohawk Valleys						
a. The sequence found in going from the limestone through the dark shale areas						
(1) Brown Forest soils						
(a) Limestone material—medium texture	36	Nellis	Amenia	Kendaia	← →	Lyons
(b) Black calcareous shale material—shallow soils	37	Palatine				
(2) Gray Brown Podzolic soils high in dark shale						
(a) Medium and moderately fine texture, high lime	38	Mohawk	Manheim	→ ←	Ilion	Fonda
(b) Moderately fine texture, medium lime	39	Leyden	Remsen	→ ←	Marcy	Alden
(c) Medium texture, medium lime	40	Poland	Turin	→ ←	Ilion	Fonda
(3) Podzols high in dark shale, medium texture						
(a) Shallow soils	41	Manlius				
(b) Deep soils with fragipans						
Wet soils are neutral	42	Pinckney	Camroden	→ ←	Marcy	Alden
Wet soils are acid	43	Pinckney	Camroden	→ ←	Gage	Mansfield
b. Shale, limestone, and granite or sandstone mixtures in the eastern part of the Mohawk Valley						
Weak Podzols with fragipans						
(a) Moderately coarse texture	44	Sacandaga	Ballston	Brayton	← →	Sun
(b) Medium texture	45	Broadalbin	Mosherville			
5. On the Ontario Plain and on eastward extensions of similar rocks on the Tughill Plateau, in the southwestern part of the Mohawk Valley, and on the northern edge of the Allegheny Plateau						
a. The sequence found in going from the sandstone area through the limestone to the calcareous shale area						
(1) Strong Podzols with fragipans						
Sandstone dominant—moderately coarse texture	46	Worth	Empeyville	Westbury	Dannemora	Tughill
(2) Weak Podzols with fragipans						
Sandstone dominant—moderately coarse texture	47	Sodus	Ira	Scriba	← →	Sun
(3) Acid Brown Earths with clayey fragipans						
Sandstone dominant—moderately coarse texture	48		Clarkson	Hulberton		
(4) Gray Brown Podzolic soils						
(a) Sandstone and limestone mixed—medium texture						
Prominent leached layer where drain-						

Key to the Soil Series of New York

PARENT material of the soil catena and selected soil characteristics of the best-drained member	Line	Soil-drainage class: Good or excessive	Moderately good	Somewhat poor	Poor	Very poor
(b) Gray lake clay, shale, and sandstone mixed—moderately fine texture	71	Canaseraga	Dalton			
(c) Gray shale—moderately fine texture						
Shallow over acid shale	72		Hornell		Allis	
Shallow over alkaline shale	73		Aurora		Angola	
(3) Moderate Podzols with fragipans—very low lime soils						
(a) Gray shale and sandstone						
Wet soils are neutral	74	Bath	Mardin	Volusia	Ellery	Alden
Wet soils are acid	75	Bath	Mardin	Volusia		Chippewa
Thin solum	76	Otsego				
Humus Podzol	77			Fremont		
(b) Red and gray shale and sandstone mixed	78	Cattaraugus	Culvers	Morris		Norwich
(c) Red shale and sandstone	79	Lackawanna	Wellsboro	Morris		Norwich
	80	Walton				
(d) Sandstone mainly (Catskill Mountains)	81	Liberty				
(4) Moderate Podzols without fragipans, very low lime						
(a) Gray shale and sandstone						
Deep soils	82	Woostern				
Shallow soils	83	Lordstown	Arnot			
(b) Red shale and sandstone—shallow soils	84	Oquaga				
(c) Sandstone mainly—shallow soils	85	Catskill				
(d) Shale mainly—shallow soils	86	Manlius				
(5) Acid Brown Earths with fragipans						
Sandstone mainly—southeastern Catskill area						
Moderate fragipan	87	Swartswood				
Strong fragipan	88	Wurtsboro				
7. On Long Island						
Dominantly granitic material						
Acid Brown Earth or Gray Brown Podzolic soils						
Medium texture	89	Haven				
Moderately coarse texture	90	Plymouth				
B. SOILS FROM THE COARSE WATER-SORTED MATERIAL OF GLACIAL OUTWASH, DELTAS, AND BEACHES						
1. Medium to moderately coarse-textured soils from gravelly material						
a. Gray Brown Podzolic soils						
(1) Limestone dominant—calcareous at 12 to 24 inches	91	Kars				
(2) Deep gravel—Wet soils are medium-textured	92	Palmyra	Phelps	(Unnamed)		(Unnamed)
—Wet soils are moderately fine textured	93			Homer		Westland
(b) Over clay	94	Rippleton				
(3) Sandstone, shale, and limestone—calcareous at 36 to 70 inches	95	Howard	Phelps	(Unnamed)		(Unnamed)
(4) Sandstone and limestone—calcareous at 36 to 70 inches	96	Alton				
(5) Granite, slate, and limestone—calcareous at 36 to 70 inches	97	Copake	Hero	(Unnamed)		(Unnamed)
(6) Red shale and limestone—calcareous at 24 to 60 inches	98	Wampsville				
(7) Black calcareous shale—Brown Forest intergrade	99	Herkimer				
Wet associates are moderately fine textured	100			Houseville	Glenfield	Westland
b. Weak Podzols over deep weak zone of clay accumulation						
(1) Gray sandstone and shale mainly						
(a) Deep gravel	101	Chenango	Braceville	Red Hook		Atherton
(b) Over clay	102		Oramel			
(2) Red sandstone and shale mainly	103	Tunkhannock	(Braceville)	Red Hook		Atherton
(3) Granite with some limestone	104	Briggs				
c. Acid Brown Earths over gravel with thin clay films						
Slate and shale mainly	105	Hoosic	(Braceville)	Red Hook		Atherton
2. Coarse-textured soils from gravelly material						
a. Brown Forest soils—crystalline limestone and granite	106	Bonaparte				
b. Acid Brown Earths—sandstone with some slate	107	Otisville				
c. Weak Podzols—very deep to lime						
(1) Sandstone mainly	108	Colosse		Altmar		
(2) Granitic rocks mainly	109	Hinckley	(Sudbury)		Walpole	Scarboro
d. Strong Podzols—granitic rocks or sandstone with iron cementation	110	Colton	Duane		Walpole	Scarboro
	111	Constable				
3. Non-gravelly sandy loam soils over gravel						
a. Gray Brown Podzolic soils	112	Newfane		Somerset		
b. Acid Brown Earths (Long Island)	113	(Sassafras)				
c. Weak Podzols	114	Merrimac	Sudbury		Walpole	Scarboro
4. Loamy sand and sand soils without gravel						
a. Brown Forest soils in calcareous sands	115	Petoskey		Junius		Granby
b. Gray Brown Podzolic soils—deep acid sands	116	Ottawa		Morocco		Newton
—sand over clay	117	Ottawa	Berrien	Rimer		Wauseon
c. Acid Brown Earths—deep acid sands	118	Colonie				
—sand over clay	119		Claverack			
d. Weak Podzols—deep acid sands	120	Windsor			Walpole	Scarboro
—sand over clay	121	Melrose	Elmwood		Swanton	Whately
e. Strong Podzols—without iron cementation	122	Adams	Croghan	AuGres	Walpole	Scarboro
(on Long Island)	123	(Lakewood)				
—with iron cementation	124	Wallace		Saugatuck		
5. Sandy loam soils and very fine sandy loam soils low in silt						
a. Gray Brown Podzolic soils, fine and very fine sandy loams	125	Arkport	Galen	Junius		Granby
b. Weak Podzols						
(1) Sandy loams—deep sands	126	Agawam	Sudbury		Walpole	Scarboro
—over clay	127	Melrose	Elmwood		Swanton	Whately
(2) Very fine sandy loams	128	Hartland				
c. Strong Podzols—deep sands	129	Groveton			Walpole	Scarboro
C. SOILS FROM FINE SORTED MATERIAL, MAINLY LACUSTRINE BUT INCLUDING LOESS AND OLDER SILTY ALLUVIUM						
1. Silt loam and very fine sandy loam soils high in silt						
a. Prairie-like soils with dark surface layers	130	Hempstead				
b. Gray Brown Podzolic soils—deep calcareous silty deposits	131	Dunkirk	Collamer	(Unnamed)	Canandaigua	Colwood
—over shale	132	Medina				
—over gravel	133	Mentor				
c. Acid Brown Earths—deep silty deposits	134	Allard			Canandaigua	Colwood

a. The sequence found in going from the sandstone area through the limestone to the calcareous shale area							
(1) Strong Podzols with fragipans Sandstone dominant—moderately coarse texture	46	Worth	Empeyville	Westbury	Dannemora	Tughill	
(2) Weak Podzols with fragipans Sandstone dominant—moderately coarse texture	47	Sodus	Ira	Scriba	⟶⟵	Sun	
(3) Acid Brown Earths with clayey fragipans Sandstone dominant—moderately coarse texture	48	Clarkson		Hulberton			
(4) Gray Brown Podzolic soils							
(a) Sandstone and limestone mixed—medium texture							
Prominent leached layer where drainage is restricted	49	Ontario	Hilton	(Unnamed)	⟶⟵	Lyons	
Weak leached layer where drainage is restricted	50	Ontario	Lima	Kendaia	⟶⟵	Lyons	
Material wave-sorted	51	Whitelaw		Oneida	⟶⟵	Lyons	
(b) Limestone dominant—shallow soils	52	Farmington					
(c) Limestone and calcareous gray shale mixed							
High lime, medium texture	53	Honeoye	Lima	Kendaia	⟶⟵	Lyons	
Medium lime, medium texture	54	Lansing	Conesus	Kendaia	⟶⟵	Lyons	
(d) Limestone and red shale or lake clay mixed							
Moderately fine texture	55	Cazenovia	⟷	Ovid	Romulus	Fonda	
(e) Reddish lake clay thin over limestone till							
Moderately fine texture	56	Cayuga	⟷	Ovid	Romulus	Fonda	
(f) Gray lake clay and limestone mixed							
Moderately fine texture	57	Nunda	⟷	Burdett	Romulus	Fonda	
b. Shales dominant							
(1) Gray Brown Podzolic soils							
(a) Red calcareous shale—red fine textured soils	58	Lairdsville		Lockport	Romulus	Fonda	
(b) Greenish calcareous shale—fine textured soils	59	Canastota		Cicero	Romulus	Fonda	
(c) Gray calcareous shale							
Fine texture, very high lime	60	Riga		Brockport			
Fine texture, high lime	61			Mahoning	Trumbull	Miner	
Moderately fine texture, medium lime	62	Danley		Darien	Romulus	Fonda	
Medium textured (silty), medium lime	63	Camillus					
(2) Weak Podzols with strong fragipans Gray acid hard shale	64	Scotia	Marilla				
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a. The sequence found in going from the limestone area to the Pennsylvania state line.							
(1) Gray Brown Podzolic soils							
(a) Limestone mainly—shallow soils	65	Farmington					
(b) Limestone and shale—high-lime soils	66	Honeoye	Lima	Kendaia	⟶⟵	Lyons	
(c) Shale and limestone—medium-lime soils	67	Lansing	Conesus	Kendaia	⟶⟵	Lyons	
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(2) Weak Podzols with fragipans							
(a) Calcareous shale and sandstone—low lime soils	70	Valois	Langford	Erie	Ellery	Alden	

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—over clay	127	Melrose	Elmwood		Swanton	Whately
(2) Very fine sandy loams	128	Hartland				
c. Strong Podzols—deep sands	129	Groveton			Walpole	Scarboro
C. SOILS FROM FINE SORTED MATERIAL, MAINLY LACUSTRINE BUT INCLUDING LOESS AND OLDER SILTY ALLUVIUM						
1. Silt loam and very fine sandy loam soils high in silt						
a. Prairie-like soils with dark surface layers	130	Hempstead				
b. Gray Brown Podzolic soils—deep calcareous silty deposits	131	Dunkirk	Collamer	(Unnamed)	Canandaigua	Colwood
—over shale	132	Medina				
—over gravel	133	Mentor				
c. Acid Brown Earths—deep silty deposits	134	Allard			Canandaigua	Colwood
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(1) Grayish material	149	Genesee	Eel		Wayland	Sloan
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(2) Reddish material	151	Hamlin			Wayland	Sloan
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(1) Shale and sandstone material						
(a) Grayish material	153	Tioga	Middlebury		Holly	Papakating
(b) Reddish material	154	Barbour	Basher		Holly	Papakating
(2) Slate and phyllite material	155	Poultney	Pawlet		Housatonic	Saco
2. Moderately coarse texture, acid						
Granite, gneiss, or sandstone material	156	Ondawa	Podunk		Rumney	Saco
b. Slack-water deposits from lake clays	158		Tonawanda		Wolcottsburg	
4. Medium-textured alluvium over muck	159			Wallkill		

e Key To Soil Series

nber	Series	Line Number	Series	Line Number	Series	Line Number	Series	Line Number	Series	Line Number
	Macomber	22	Oneida	51	Riga	60	Staatsburg	26	Walpole	109, 110,
	Madalin	143, 144	Ontario	49, 50	Rimer	117	Stanley	*See* Lima		114, 120,
	Madrid	32	Oquaga	84	Rippleton	94	Stissing	24		122, 126,
	Mahoning	61	Oramel	102	Rockaway	5	Stockbridge	18		129
	Manheim	38	Orono	*See* Madalin	Romulus	58, 59, 62,			Walton	80
5	Manlius	41, 86	Orwell	157		55, 56, 57,	Sudbury	109, 114	Wampsville	98
	Mansfield	24, 43	Otisville	107		68		126	Wassaic	3, 17
15,	Marcy	39, 42	Otsego	76	Ross	150	Suffield	148	Waumbek	10
, 36,	Mardin	74, 75	Ottawa	116, 117	Rumney	156	Sun	30, 34,	Wauseon	117
66, 67	Marilla	64	Ovid	55, 56	Saco	155, 156		44, 47	Wayland	149, 150,
	Massena	30, 34	Palatine	37	Sacandaga	44	Sutton	13		151, 152
	Medina	132	Palmyra	92	Salmon	139	Swanton	121, 127	Wellsboro	79
	Melrose	121, 127	Panton	141	Sassafras	113	Swartswood	27, 87	Westbury	29, 35, 46
	Mentor	133	Papakating	153, 154	Saugatuck	124	Tioga	153	Westland	93, 100
	Merrimac	114	Parishville	34	Scantic	148	Toledo	143, 144	Whately	121, 127
	Middlebury	153	Pawlet	155	Scarboro	109, 110,	Tonawanda	158	Whitelaw	51
	Miner	61	Petosky	115		114, 120,	Trout River	33	Whitman	7, 8, 10,
3	Mohawk	38	Phelps	92, 95		122, 126,	Troy	21		11, 13, 14
	Moira	34	Pinckney	42, 43		129	Trumbull	61	Williamson	136
	Morocco	116	Pittsfield	1	Schodack	*See* Howard	Tughill	29, 35, 46	Windsor	120
66	Morris	78, 79	Pittstown	24	Schoharie	146	Tunkhannock	103	Wolcottsburg	158
	Mosherville	45	Plymouth	90	Scio	137	Turin	40	Woodbridge	14
	Nassau	19	Podunk	156	Scituate	8	Unadilla	137	Wooster	*See* Woostern
	Nellis	15, 31, 36	Poland	40	Scotia	64	Valois	70	Woostern	82
	Newfane	112	Poultney	155	Scriba	47	Vergennes	141	Worth	29, 35, 46
	Newton	116	Poygan	146	Shapleigh	6	Volusia	74, 75	Wurtsboro	28, 88
	Nicholville	139	Red Hook	101, 103,	Shoreham	157	Vrooman	138	Yates	*See* Honeoye
15,	Ninigret	135		105, 137	Skerry	11	Wallace	124		
32,	Norwich	78, 79	Remsen	39	Sloan	149, 150,	Wallkill	159		
60,	Nunda	57, 68	Retsof	69		151, 152	Wallington	136, 139		
34,	Odessa	146	Rhinebeck	143	Sodus	47				
	Ondawa	156	Ridgebury	8, 11, 14	Somerset	112				

: Cornell University, Ithaca, New York. M. C. Bond, Director of Ex-
poses provided for in the Acts of Congress of May 8 and June 30, 1914.

There is little agriculture on most of these areas. Very low water-holding capacity makes most areas non-agricultural unless supplemental irrigation is provided. Small fruits, early vegetables, and general farm crops grow successfully in a few places where the water relationships are most favorable. The fertility problem is second only to drouthiness. The soils are very low in lime, potash, and phosphorus, and generally are also deficient in nitrogen where they have been cleared. Wind erosion is serious in some areas.

WA **Williamson–Amboy Association**—This association comprises undulating areas of moderately well- and well-drained soils developed in lacustrine silts and very fine sands. On the nearly uniform gentle slopes is found the moderately well-drained Williamson which occupies from 30 to 50 percent of the association. The well-drained Amboy on the convex knolls occupies from 20 to 40 percent. Both of these soils are strongly acid, stone-free, and low in fertility. They have, however, good water-holding capacity, so they can be expected to respond well to fertilization and liming. On the flat areas and depressions, the somewhat poorly drained Wallington and the very poorly drained Birdsall soils appear as minor constituents. The excessively drained, sandy Windsor soils and the poorly drained sands are inclusions that may be important locally.

The dominant soils are adapted to almost all crops suited to the climate, although alfalfa and tree fruits may be limited by poor subsoil aeration in areas of Williamson soils. All crops require intensive fertilization, but the response should be high. Lime, phosphorus, and potash are uniformly low; and although organic matter and nitrogen are moderately high, the release of nitrogen is too slow for rapidly growing crops. There is considerable evidence of erosion, even on gentle slopes, for the dominantly silty materials are very erodible. As on the Salmon-Nicholville association, the physical condition of the soils is excellent.

WE **Westbury–Empeyville Association**—Long, uniform, gentle slopes are dominant in these areas. They have a covering of glacial till consisting almost entirely of sandstone material. The dominant soils on this landscape have well-developed fragipans at 15 to 24 inches. On the long, uniform, gentle slopes, the somewhat poorly drained Westbury soils dominate, occupying from 35 to 65 percent of the association. On the knolls or other distinctly convex land forms, the moderately well-drained Empeyville is found. It occupies from 5 to 20 percent of the association. The poorly drained Dan-

nemora on the nearly level areas occupies from 15 to 30 percent of the association. The drouthy gravelly Colton or soils of the Parishville catena may appear as local inclusions important on some farms. All of the association is stony and about one-fourth is too stony for cultivation.

Restricted drainage and low fertility are the outstanding problems. Corn for silage, oats, hay, and potatoes are the most common crops. In years of nearly normal rainfall, the planting of oats is delayed for only short periods by wetness. Frequently, wetness may seriously delay planting of both oats and potatoes. Lack of a persistent legume and slow nitrification in cold wet soil make nitrogen deficiency conspicuous on some growing crops. The soils are very strongly acid and are very low in both phosphorus and potash. These areas can, however, produce moderately good yields, but the costs of good management to obtain them are high relative to costs on better drained and more fertile areas.

WH **Wayland–Eel and Holly–Middlebury Associations**—The soils of this association are on first bottomlands that are generally too wet for cultivation. The poorly drained Wayland or Holly occupy from 40 to 70 percent of most areas. The moderately well-drained Eel or Middlebury is on the highest-lying areas nearest the river. Locally, well-drained soils on terraces or bottomlands appear as important inclusions that make excellent cropland.

Most areas are forested or used principally for pasture. In some places there is productive cropland on the Eel or Middlebury soils or on the included soils of terraces. These soils, where artificially drained, may be cropped successfully, but they still have a serious flood hazard. Although the soils are more fertile than the associated soils of the uplands, they respond to phosphorus and usually to potash under intensive cropping.

WM **Woostern–Mardin Association**—In this association the soils are mainly well- and moderately well-drained and are from glacial till on rolling topography. The glacial till is derived from sandstone and shale and, although it may be calcareous at depths of 6 to 10 feet, the soils developed in it are very strongly acid. On the irregular, convex, rolling topography, the well-drained Woostern soils are found. They occupy from 30 to 60 percent of the association. The Woostern soils are replaced by Valois near the northern limits of the areas. On the less strongly rolling topography but still on distinctly convex slopes are the moderately well-drained Mardin soils.

Mardin accounts for 20 to 40 percent of the association. On the uniformly sloping parts where water is not disposed of rapidly, the somewhat poorly drained Volusia or Erie soils predominate. They occupy from 10 to 20 percent of the association. Locally, Bath, Ellery, or Howard soils may appear as important inclusions. About one-fifth of the area is strongly sloping, and most slopes are irregular.

Although corn, oats, wheat, beans, peas, and sweet corn are at least moderately productive, the uneven relief and the generally moderate to strong slopes limit the use of intertilled crops and makes the use of sod crops especially important to control water. Fertility maintenance is a major problem. The soils are very strongly acid and are low in both phosphorus and potash. Erosion control is an important problem on these areas. Drainage is a problem mainly in local areas of small acreages. The soils are responsive to good management and are limited in crop adaptation mainly by the character of the slopes.

Worth–Empeyville–Westbury Association, Very Stony—On these gently sloping to hilly areas, dominated by glacial till from sandstone, the soils of the Worth catena occupy about 90 percent of the association. They appear in varying proportions in different localities. Almost all areas are very stony and are therefore non-agricultural. Locally, there are areas of Colosse or Colton soils cultivated with rather poor results. No attempt has been made to differentiate these dominantly non-agricultural areas on the basis of proportions of the constituent soils.

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